

Imperial Institute

TANNING MATERIALS
OF THE
BRITISH EMPIRE

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PREFACE

THE question of the supply of tanning materials has received much attention at the Imperial Institute and many products of this class from various parts of the Empire have been examined in its laboratories. The results of these investigations will be found recorded in the volumes of the BULLETIN OF THE IMPERIAL INSTITUTE during the past twenty-five years. On the reorganisation of the Institute in 1926 it was considered desirable to devote special attention to this subject, and for this purpose an Advisory Committee on Tanning Materials was appointed, one of the chief functions of which is to explore new sources of these materials.

In view of the present position it was thought that a general account of the principal tanning materials of Empire origin would serve a useful purpose, and a series of four articles on the subject, prepared by members of the Institute staff, was published in the BULLETIN during 1927 and 1928.

The present publication consists of these articles, revised and brought up-to-date, together with additions suggested by the Committee on Tanning Materials. The Institute is specially indebted to Dr. E. C. Snow, Manager of the United Tanners' Federation, who has kindly supplied statistics showing the consumption of tanning materials in the United Kingdom and the graphs illustrating price fluctuations in recent years.

W. T. FURSE, *Lieut.-General,
Director of the Imperial Institute.*

October. 1929.

TANNING MATERIALS OF THE BRITISH EMPIRE

INTRODUCTION

FOR some time past the question of future supplies of vegetable tanning materials has been a matter of some anxiety in the leather industry, not only of the United Kingdom but throughout the world. During the war there was an enormous demand for such products, but certain countries were temporarily cut off from the world market, and the normal disposal of raw material underwent a considerable change. This dislocation of trade has gradually been overcome, and the consumption of tanning materials in the last few years may be taken as an index of the future requirements of the industry. These years show a steadily increasing consumption, and attention has been directed to a consideration of the world's resources with regard to the future.

From the accompanying table (pages 4 and 5), for which the Imperial Institute is indebted to Dr. E. C. Snow, Manager of the United Tanners' Federation, it will be seen that in the United Kingdom more than half the tanning materials consumed, expressed as tannin units, are derived from foreign countries, the largest item being quebracho extract from the Argentine. There is consequently a large field for the expansion of Empire production, not only in providing the additional tannin units required in the future, but in rendering the leather industries of the Empire as far as possible independent of foreign supplies. The Imperial Institute Advisory Committee on Tanning Materials are taking steps to encourage the production of tanning materials in British countries and to introduce new tanstuffs that are of promise.

The countries of the British Empire which produce

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tanning materials of commercial importance, and the principal materials produced, are shown in the following table.

	<i>For local use and export.</i>	<i>For local use only.</i>
South Africa	Wattle bark	—
Australia	Wattle bark	—
	Mallet bark	—
Canada	—	Eastern Hemlock bark Western Hemlock bark
India	Myrobalans Divi-divi Cutch	Babul bark Avaram bark Wattle bark
British North Borneo	Mangrove bark	—
British Malaya	Gambier Mangrove bark	—
Sudan	Sant pods	—
British East Africa	Mangrove bark Wattle bark	—
Nigeria	—	Gabarru pods
Jamaica	Divi-divi	—
Cyprus	Sumach	—
United Kingdom	—	Oak bark Larch bark

The various tanning materials dealt with in the following pages include not only those in established use but also those worthy of consideration as new articles of commerce. The well-known materials are described in the following order : barks, woods, leaves, fruits and tubers ; a later section is devoted to lesser known materials that are of interest.

BARKS

WATTLE BARK

Wattle bark is one of the most valuable and extensively employed tanning materials of the British Empire, and is meeting with increasing popularity with British tanners. At the suggestion of the United Tanners' Federation the Imperial Institute made enquiries a few years ago as to the possibility of extending the production of wattle bark within the Empire, and again more recently the question of fresh sources of supply has been considered by the Imperial Institute Advisory Committee on Tanning Materials. It has been shown that several countries possess suitable conditions for growing bark of good quality, but that the establishment or development of an export

industry at the present time would in many cases be hampered by the existing high freights.

Wattle bark is produced from species of *Acacia*, of which the most important commercially is the black wattle (*A. mollissima* Willd. = *A. decurrens* Willd. var. *mollis* Lindl.). The wattles, or mimosas as they are sometimes called, which are employed as a source of tanning bark, are of Australian origin, and certain of them have been introduced into other parts of the Empire, including Natal and elsewhere in South Africa, as well as Kenya and India. The greatest development in the wattle bark industry has taken place in Natal, where the conditions are specially favourable to the production of the bark, the climate having proved eminently suitable to the black wattle, and a plentiful supply of cheap labour being available. Moreover, Natal has been fortunate in finding a ready local market for the wood (left after the bark has been stripped), which is largely employed for mine props and as fuel. This question of the utilisation of the wood is a most important one in determining the success of a wattle bark industry, and a recent estimate of the returns from a plantation in Natal shows that of the total receipts 56 per cent. was derived from the sale of bark, 33 per cent. from mine props and 11 per cent. from fuel.

Many references have been made in the BULLETIN OF THE IMPERIAL INSTITUTE to wattle bark and its production, and also to the possible commercial utilisation of the by-products of the industry. The following are the principal articles dealing with the subject : "Production and Utilisation of Wattle Bark," 1908, 6, 157 ; "Wattle Barks from the Transvaal and the East Africa Protectorate," 1910, 8, 245 ; "The Utilisation of Wattle Bark," 1911, 9, 116 ; "Black Wattle Bark from the East Africa Protectorate," 1913, 11, 402 ; "Destructive Distillation Trials with Black Wattle Wood," 1916, 14, 570 ; "The Wattle-bark Industry of Natal," 1916, 14, 599 ; "Wattle Bark and Wood" (Paper-making trials), 1917, 15, 496 ; "Black Wattle Wood Ash from the East Africa Protectorate," 1919, 17, 281 ; "Wattle Bark from Ceylon," 1923, 21, 466 ; "The Cultivation of Black Wattle," 1923, 21, 607.

CONSUMPTION OF TANNING MATERIALS IN THE UNITED KINGDOM

Material.	Chief Countries of Origin.	Tannin Content. Per cent	1913.			1922.			1925.		
			Tons.	Weight. £	Tannin Units	Tons.	Weight. £	Tannin Units	Tons.	Weight. £	Tannin Units
Wattle bark	•	34	10,720	3,650	80,000	25,500	8,670	242,000	17,000	5,780	178,000
Myrobalans	•	32	27,160	8,830	171,000	24,570	7,860	180,000	25,800	8,260	301,000
Wattle extract	•	60	—	—	—	6,500	3,900	149,000	7,350	4,410	160,000
Gambier.	•	—	—	—	—	—	—	—	—	—	—
Larch bark	•	36	4,680	1,680	130,000	3,950	1,420	139,000	1,600	580	105,000
Oak bark	•	10	800	80	60,000	800	80	70,000	10,000	1,000	60,000
Myrobalans extract	•	11	12,000	1,320	10,000	1,100	—	—	—	—	—
Hemlock extract	•	60	1,200	720	13,000	1,400	840	27,000	920	550	24,600
Chestnut extract	•	60	300	180	4,000	300	180	6,000	—	—	—
Quebracho extract	•	29	4,900	1,450	46,000	500	150	13,000	660	190	20,000
" " "	•	27	35,800	9,580	430,000	18,600	5,020	335,000	10,400	2,810	177,000
Argentina	•	63	7,000	1,900	88,000	6,900	1,860	137,000	11,400	3,080	191,000
Sumach	•	28	8,100	5,100	142,000	10,700	6,740	259,000	21,830	13,750	439,000
Valonia	•	7,300	2,040	74,000	5,150	1,440	71,000	4,700	1,340	125,000	—
Turkey and Greece	•	17,100	5,310	161,000	5,300	1,640	63,000	9,300	2,880	113,400	—
Turkey	•	1,100	700	26,000	460	300	16,000	2,40	150	7,600	—
Miscellaneous materials	•	1,050	400	10,000	2,800	1,120	36,000	2,100	630	25,600	—
Miscellaneous extracts	•	3,000	1,300	39,000	1,100	330	26,000	3,900	1,560	89,800	—
Total	•	142,210	44,240	1,474,000	124,530	42,650	1,769,000	127,200	46,970	2,008,000	—

CONSUMPTION OF TANNING MATERIALS IN THE UNITED KINGDOM—*continued*

CONSUMPTION IN UNITED KINGDOM

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Material.	Chief Countries of Origin.	—		1926.		1927.		1928.			
		Tannin Content Per cent.	Weight Tons	Tannin Units. £	Value. £	Weight. Tons	Tannin Units. £	Value. £	Weight. Tons	Tannin Units. £	Value. £
Wattle bark	S. Africa	34	18,400	6,260	179,000	19,000	6,460	230,000	16,200	5,500	230,000
Myrobalans	India	32	30,140	9,650	300,000	32,000	10,240	328,000	32,300	10,340	351,500
Wattle extract	S. Africa	60	5,970	3,580	136,000	7,340	4,400	169,300	3,500	2,100	99,000
Gambier.	S. Settlements and Dutch E.I.	36	1,410	510	65,300	1,890	680	76,000	2,450	880	88,100
Larch bark	United Kingdom	10	10,000	1,000	60,000	10,000	1,000	60,000	10,000	1,000	60,000
Oak bark	India	60	570	340	13,000	1,760	1,060	29,300	1,200	720	29,500
Myrobalans extract	Canada	60	—	—	—	—	—	—	—	—	—
Hemlock extract	U.S.A.	29	590	170	15,650	650	190	18,400	1,000	290	30,300
Chestnut extract	France	27	12,820	3,460	207,170	16,690	4,510	291,100	19,200	5,180	343,000
" "	Italy	27	11,820	3,190	201,760	11,930	3,220	206,520	7,800	2,110	157,000
Quebracho extract	Argentina	63	17,400	10,960	349,300	18,540	11,680	452,600	25,900	16,300	666,000
Sumach.	Italy	28	4,970	1,390	93,300	5,240	1,470	80,900	5,250	1,470	70,200
Valonia.	Turkey and Greece	31	5,800	1,800	65,700	4,700	1,460	63,400	5,600	1,740	81,300
Valonia extract	Turkey	64	5	100	60	3,400	100	60	3,100	760	490
Miscellaneous materials			3,280	980	42,700	3,370	1,010	39,700	4,100	1,230	46,900
Miscellaneous extracts			4,030	1,610	86,020	6,340	2,540	122,680	7,640	3,060	143,800
Total			127,300	44,960	1,819,000	139,550	49,980	2,171,000	142,900	52,410	2,413,000

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Wattle, like quebracho, is an astringent catechol tannin. It lends itself particularly to sole-leather manufacture, but can also be used very successfully for light leather. Although classed as a rapid tanning material, it is stated that the tannin does not penetrate quite so quickly as quebracho, but the colour of the leather is much less red than that obtained from many other catechol tans. The tanning liquors produce very little acid on fermentation, and in consequence do not plump well; wattle therefore makes a good blend with acid-producing tanning materials, such as myrobalans. Wattle leather is firm and durable. The solubility of wattle tannin compares very favourably with that of other commercial vegetable tannins, and the temperature and concentration of the extraction are not so important a factor as is the case with quebracho.

Union of South Africa.—Although several species of *Acacia* are indigenous to South Africa, those wattles of importance as tanning materials were introduced from Australia, according to C. O. Williams, some 60 years ago. They were first planted for ornamental purposes and as shelter-belts for stock, the wood being used for fencing or fuel. When the value of black wattle bark as a tanning material was afterwards realised locally, samples were sent to London, where in 1886 a good price was obtained for a small consignment of this bark. The cultivation of wattles in South Africa has been so greatly extended that the production of wattle bark has become one of the chief industries of the country. The species now cultivated in South Africa is the black wattle, *Acacia mollissima* Willd., which was selected, after many experiments with the best Australian wattles, as being harder, more suited to the climate, and furnishing on the whole a larger yield of bark than the other species, although the bark contains less tannin than that of the golden wattle, *A. pycnantha* Benth.

The trees, which are readily propagated from seed, are planted out in rows usually about 9 to 12 ft. apart, and 6 ft. apart in the line. The rotation was formerly

from 6 to 7 years, but according to T. R. Sim it now varies from 7 to 12 years, and the trees would appear to be generally felled in the 8th year. The longer rotation is found to be more remunerative in normal times, for it allows the timber, which not many years ago was considered a waste product, to be utilised as mine props, and this outlet now constitutes a large and important industry. In some circumstances, however, it pays to cut the trees at an earlier stage, and it is understood that in a recent season, owing to the scarcity of the bark and consequent high prices, quite young trees, 5 to 6 years old, have been stripped. The returns per acre vary according to locality, but are stated (T. R. Sim) to be generally about 4 tons of bark and 20 tons of timber for an 8-year-old crop.

The question of finding a profitable outlet for surplus timber has become of considerable importance, and is receiving the serious attention of the South African authorities. The requirements of the mines in this respect are stated to be already well met, and large quantities of wattle wood are at present unmarketable owing to the distances from the railway. Consideration has been given to the possible utilisation of the waste wood for paper making, and for the production of acetic acid, methyl alcohol, acetone, tar oils and charcoal by destructive distillation ; the results of experiments carried out in this direction at the Imperial Institute have been published in the *BULLETIN OF THE IMPERIAL INSTITUTE* (1916, 14, 570 ; 1917, 15, 496 ; 1929, 27, 176).

It is understood that the economic aspect of the production of wattle wood-pulp is now being studied by the Forest Department ; the results so far appear to have been encouraging, but no definite conclusions have yet been published. The prospects of employing the wood for destructive distillation appear to be less promising, at the present time, owing to competition with methyl alcohol, acetic acid and acetone prepared by other methods.

Investigations have also been made by the Forestry Department into the seasoning of wattle wood, in connection with an enquiry into the possible uses of the wood

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as sawn timber. The seasoning results are stated to have been very good and no defects due to the process occurred.

The area of wattle under cultivation, according to the last Agricultural Census of Plantations and Indigenous Forests in 1926, and also the figures given in the previous census in 1921, were as follows :

	1921. Acres.	1926. Acres.
Natal	222,778	231,211
Transvaal	49,289	49,178
Cape of Good Hope	15,110	27,847
Orange Free State	1,249	1,943
Total	<hr/> 288,426	<hr/> 310,179

For the next year or two subsequent to 1921, it is understood that the total area devoted to wattle was appreciably reduced, but it has since recovered, and during 1927 it is estimated that a further 30,000 to 40,000 acres of new lands were planted. The industry is stated to be making satisfactory progress in the Transvaal and the Cape ; in these Provinces, however, the area in which wattle will thrive sufficiently well is somewhat limited in comparison with Natal. It is stated that about 30 per cent. of the wattle plantations are owned by large syndicates which are their own exporters or which manufacture extract.

Although prior to the war the United Kingdom received the larger proportion of the South African exports, amounting in 1913 to nearly 70 per cent., most of the bark was re-exported to Germany, where it was largely converted into extract. Hence Germany at that time was by far the Union's largest customer. With the advent of the war, however, when the supply of Turkish valonia and other commercial sources of tannin were cut off, British tanners were compelled to replace them largely by wattle bark and its extract, and thus the high value of wattle bark as a tanning material became more widely recognised. There can be no doubt that the general experience gained has resulted in a greater proportion of wattle being employed in British tanning.

In the accompanying table (p. 11), showing the exports of wattle bark from the Union of South Africa since 1914, it will be observed that during the years 1921 to 1925

Germany again became the largest consumer of Natal bark. The year 1926, however, witnessed a marked fall in the direct shipments to Germany, but it may be pointed out that a very large proportion of the bark exported to Belgian and Dutch ports eventually finds its way to Germany. The figures for 1927 show that the amounts of wattle bark exported to Germany and Belgium were both in excess of that exported to the United Kingdom.

A more recent development in Natal has been the production of wattle bark extract, which was not seriously commenced on a commercial scale until 1916, when an extract factory was erected in Pietermaritzburg, and was followed soon afterwards by factories in other parts of Natal. To-day the largest manufacturer of solid wattle extract possesses three up-to-date, fully-equipped extract factories, collectively capable of producing 24,000 tons of extract per annum and each able to deal with 25,000 tons of green bark annually. The productive capacity of the other manufacturers in Natal is about 18,000 tons of extract a year. According to the secretary of the Wattle and Timber Growers' Association the present value of the South African wattle industry may be assessed, at a conservative estimate, at £2,000,000 a year, of which more than half is money brought into the country by the export of bark and extract. The rapid growth of the industry is shown by the accompanying table of exports (see page 11).

During the last few years there has been a considerable decline in the market price of wattle extract, which is determined by that of quebracho extract, and an enquiry into the conditions of the industry was made in 1924 by the Board of Trade and Industries, Industries Division, Department of Mines and Industries, Union of South Africa. The following is a summary of the recommendations made : (a) A thorough survey of the whole country by the Forest Department ; (b) the offer by the Government of substantial prizes to growers for the production, on a commercial scale, of bark with a high tannin content ; (c) that an officer be detailed to watch the interests of growers, and especially to assist in establishing conditions

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for marketing on business lines, these conditions including credit from the Land Bank and the grading of bark ; (d) the reduction of ocean freight on wattle extract ; (e) a revision of the railway rates on bark and extract.

The Forest Department of the South African Government are now undertaking a comprehensive scheme of sylvicultural research in co-operation with the Wattle and Timber Growers' Association. It is proposed to set up experimental plots in different localities from south-eastern Transvaal to southern Natal, upon which observations and measurements will be carefully made and recorded, dealing with every phase upon which there is divergence of opinion. Some of the more important aspects which will be studied include annual growth measurements over the period of rotation showing maximum height and volume increment under various conditions. The data thus collected will enable the growers or prospective investors to estimate accurately the amount of wood and weight of green or dry bark per acre in a plantation of any age, if the site quality is correctly assessed. From standard yield tables so compiled, it will be possible to determine the age at which the crop must be felled in order to obtain the highest financial returns. The effect of esplacement on the yields of bark and wood at any age in different localities is also to be ascertained, and whether the costs of clean cultivation and the continuous removal of grass are justified by results. Other experiments will be carried out to decide whether the popular practice of burning for the disposal of slash, and for the alleged good germination of seed which ensues, really produces beneficial results ; whether the black wattle (*Acacia mollissima*) or the green wattle (*A. decurrens* Willd. var. *normalis* Benth.) furnishes the better returns on land infested with the froghopper and bagworm. In all experimental plots data will be collected on the incidence and extent of insect attacks, and experiments will be conducted to discover the most effective fertilisers, and the corresponding amounts advised per acre.

Natal wattle bark, in air-dried condition containing usually 10 to 12 per cent. of moisture, is shipped in bags or bales either as stick bark, chopped bark, compressed

WATTLE BARK

II

Exports of Wattle Bark from South Africa

Year.	United Kingdom	Australia	United States.	Germany	Japan.	Belgium	Holland	Other Countries	Total.
Quantity in Short Tons (2,000 lb)									
1914 .	—	—	—	—	—	—	—	—	65,108
1915 .	33,966	8,496	1,540	—	3	—	—	826	44,831
1916 .	28,399	5,817	12,783	—	890	—	—	9,082	56,971
1917 .	25,508	9,041	3,138	—	1,965	—	—	6,623	46,275
1918 .	39,950	4,253	2,479	—	5,764	—	—	1,506	53,952
1919 .	20,809	6,946	20,291	—	5,937	1,810	2,620	4,909	63,322
1920 .	36,460	3,213	20,470	3,466	5,582	2,229	2,133	5,358	78,911
1921 .	14,298	3,169	6,777	38,188	10,685	1,449	2,781	2,595	79,942
1922 .	28,786	3,796	10,009	73,731	6,652	3,384	3,476	6,024	135,858
1923 .	34,444	9,113	13,074	36,269	8,323	4,001	5,761	9,077	120,662
1924 .	21,831	3,495	7,932	24,102	9,165	4,144	23,558	7,898	101,825
1925 .	20,427	1,720	9,832	30,320	7,364	12,003	18,548	11,060	111,774
1926 .	20,905	4,729	8,657	11,910	9,734	15,467	7,222	11,420	90,094
1927 .	21,589	794	11,158	22,792	8,255	25,991	2,242	12,464	105,285

Value in £.

Year.	United Kingdom	Australia	United States.	Germany	Japan.	Belgium	Holland	Other Countries	Total.
Value in £.									
1914 .	—	—	—	—	—	—	—	—	286,399
1915 .	150,415	35,102	6,156	—	13	—	—	3,558	195,244
1916 .	129,287	24,772	53,570	—	4,063	—	—	43,172	254,864
1917 .	131,116	39,856	14,266	—	9,265	—	—	29,479	223,982
1918 .	218,484	19,472	12,232	—	29,700	—	—	7,332	287,220
1919 .	135,664	35,854	122,026	—	35,347	11,797	19,578	25,830	386,096
1920 .	325,697	23,653	168,647	23,160	44,467	18,127	16,455	42,300	662,515
1921 .	90,588	16,482	36,476	214,886	60,914	8,791	16,203	12,978	457,318
1922 .	173,923	21,033	55,597	433,400	41,390	18,571	19,808	36,158	799,942
1923 .	191,098	47,873	66,598	197,706	46,584	24,071	32,252	53,115	659,297
1924 .	128,432	20,537	43,623	132,876	52,574	24,830	134,242	46,858	583,972
1925 .	146,604	11,947	68,023	204,598	56,789	84,417	130,574	78,141	781,093
1926 .	143,411	30,629	54,588	74,191	64,725	103,993	46,168	75,065	592,830
1927 .	180,149	6,381	79,912	181,782	73,657	220,964	15,606	109,817	868,268

Exports of Wattle Bark Extract from South Africa

Year.	United Kingdom	Australia	United States.	Germany	Japan.	Belgium	Holland	Other Countries	Total.
Quantity in Short Tons (2,000 lb)									
1916 .	491	—	—	—	—	—	—	—	491
1917 .	1,184	45	6	—	45	—	—	112	1,392
1918 .	3,564	292	—	—	133	—	—	180	4,169
1919 .	6,513	249	35	—	13	—	31	39	6,880
1920 .	7,541	310	713	—	217	59	17	641	9,498
1921 .	3,590	40	684	714	65	238	92	46	5,469
1922 .	6,534	74	—	4,131	68	465	393	510	12,175
1923 .	11,277	125	—	4,396	431	459	103	689	17,440
1924 .	8,178	88	143	4,531	212	1,025	898	1,979	17,047
1925 .	9,799	72	399	5,484	524	1,066	804	2,015	20,163
1926 .	7,552	90	111	7,300	353	1,832	646	1,388	19,272
1927 .	7,035	53	135	6,259	430	1,637	1,500	312	17,361

Value in £.

Year.	United Kingdom	Australia	United States.	Germany	Japan.	Belgium	Holland	Other Countries	Total.
Value in £.									
1916 .	14,930	—	—	—	1,550	—	—	—	14,930
1917 .	42,202	1,600	168	—	4,505	—	—	4,000	49,520
1918 .	103,600	10,360	—	—	1,300	—	940	6,410	124,875
1919 .	204,440	7,094	1,089	—	—	—	1,223	216,086	
1920 .	203,449	11,043	16,292	—	8,124	2,261	581	22,219	323,969
1921 .	72,296	697	18,444	12,595	1,550	4,501	1,872	854	112,809
1922 .	109,467	1,222	—	68,912	1,196	8,179	6,157	8,064	203,107
1923 .	168,788	2,011	—	68,527	7,182	7,296	1,623	10,657	260,084
1924 .	122,284	1,324	2,155	69,121	3,195	16,001	12,652	30,068	256,800
1925 .	158,528	1,131	6,472	90,761	8,547	17,252	13,013	32,364	328,068
1926 .	126,387	1,440	1,900	124,807	5,850	29,034	10,398	24,521	324,337
1927 .	119,056	893	1,299	104,860	7,098	26,280	25,484	5,414	291,384

bark or shredded or ground bark. Bales of chopped bark take up a space of 85 cu. ft. per ton, compressed bark about 55 cu. ft. and ground bark 50 cu. ft. The percentage of tannin in the bark ranges from 30 to 45 per cent., with an average of about 33 per cent. The solid extract, which contains about twice as much tannin as the bark, occupies a space of about 40 cu. ft. per ton.

Commonwealth of Australia.—Australia, the home of the wattle, can boast of more than 400 indigenous species of *Acacia*. This country, which formerly afforded the only commercial source of the bark, has for some years produced an insufficient quantity for home consumption, and finds it necessary to import some 3,000 tons annually from South Africa.

The two most important Australian commercial species are (1) the golden wattle, *A. pycnantha*, which occurs principally in South Australia, and to a smaller extent in Victoria and the south-west of New South Wales, and (2) the more hardy black wattle, *A. mollissima*, the species which gives the best results in the other States. The approximate total acreage in the Commonwealth, excluding Tasmania, is estimated at 227,000 acres of black wattle and 128,000 acres of golden wattle.

A. pycnantha provides one of the richest known tanning barks, analyses being recorded which show up to 50 per cent. of tannin in the air-dried material. The best commercial *A. pycnantha* bark, known as "Adelaide bark," contains on an average about 38 per cent. of tannin. Australian *A. mollissima* bark contains from 31 to 39 per cent. of tannin. It is stated that the black wattle bark sold in Sydney is generally a mixture of *A. mollissima* and *A. decurrens* var. *normalis* giving a tannin value of about 30 per cent., but that it sometimes contains a large proportion of the inferior silver wattle bark (*A. dealbata* Link), which usually contains not more than 20 per cent. of tannin.

Unlike the South African industry, that of Australia has been dependent on natural forests, where the trees are of different ages and often of mixed varieties, so that the bark has not the even quality of the South African product.

Since the year 1905 the output of tanning barks in

Australia has gradually decreased. This decline has been due to the depletion of the forests by the general destruction of the trees and the consequent necessity of having to push further and further afield from the markets, since re-afforestation has not been practised to any extent. In view of the very favourable conditions under which the Natal industry is conducted, as regards environment, labour supply and market for the wood, the opinion has been expressed that Australian wattle bark can only hope to compete with Natal bark when some mechanical means has been devised for stripping the bark or more profitable use is made of the by-products of the industry, or possibly only when both these conditions have been fulfilled.

The following tables show the amounts of tanning bark exported from the Commonwealth during the last five years for which figures are available, and also the quantities employed in the tanneries of each State.

Tan Bark—Domestic exports from Australia, 1922-23 to 1926-27

	Quantity (cwt.)					Value (£)				
	1922-23	1923-24	1924-25	1925-26	1926-27	1922-23	1923-24	1924-25	1925-26	1926-27
United Kingdom.	12	—	—	104	—	3	—	—	58	—
New Zealand.	11,034	5,218	3,847	676	1,633	7,604	3,240	2,199	503	1,355
Other British Possessions.	309	—	332	—	102	194	—	170	—	51
Germany.	—	9,005	36,081	303	2,050	—	4,983	19,587	159	1,272
Netherlands.	—	—	—	3,033	2,050	—	—	—	1,550	1,272
Other Foreign Countries.	4,490	3,213	2,272	2,000	100	2,220	2,106	1,155	1,350	60
Total.	15,845	17,436	42,532	6,116	5,935	10,021	10,329	23,111	3,620	4,010

Note.—These exports include other tanning barks besides wattle bark, and during the last two years have consisted largely of mallet bark from Western Australia, which is not used extensively in Australian tanneries but is exported to Germany for extract making.

Total Imports and Exports of Tan Bark, 1922-27

Year.	Imports.		Exports.		Excess of Imports.	
	Cwts.	£	Cwts.	£	Cwts.	£
1922-23	93,769	37,349	17,529	10,716	76,240	26,633
1923-24	73,941	28,672	17,601	10,418	56,340	18,254
1924-25	28,628	11,821	42,794	23,332	14,166 ¹	11,511
1925-26	44,372	21,498	6,448	3,818	37,924	17,680
1926-27	57,305	27,684	5,935	4,010	51,370	23,674

¹ Excess of Exports.

14 TANNING MATERIALS OF THE BRITISH EMPIRE

Tan Bark used in the Tanneries of the Commonwealth

Quantity in Tons

—	New South Wales.	Victoria.	Queens-land.	South Australia	Western Australia	Tasmania.	Total.
1921-22 .	11,836	13,852	2,411 (1921)	1,329	924 (1921)	469 (1921)	30,821
1922-23 .	11,524	13,683	2,739 (1922)	1,166	1,091 (1922)	467 (1922)	30,670
1923-24 .	11,015	13,166	2,529 (1923)	1,111	1,036 (1923)	419	29,276
1924-25 .	10,639	12,085	1,839	967	1,211 (1924)	270	27,011
1925-26 .	11,746	11,772	1,891	810	1,234 ¹	291	27,744

¹ 18 months ended June 1926.

In most cases definite information is not available as to the exact extent of the natural wattle forests in each State of the Commonwealth, or as to the actual area at present under cultivation; the following particulars, however, give some idea of the wattle resources of the Dominion.

New South Wales.—The principal species in this State is the black or green wattle, which flourishes best in the colder districts, chiefly on the southern table-lands. The relatively small quantity of golden wattle is practically confined to parts of the country bordering on South Australia and Victoria.

With a view to the perpetuation of wattle trees for the production of the bark, the State Forest Commission a few years ago withdrew from settlement 37,500 acres of Crown lands in the vicinity of Buckenbourg on the coast in the south of the State, where some of the best bark is said to be obtained. The black wattle is widely distributed in this area, and steps were taken in 1919 to set apart portions of the land for retention as a national permanent reserve for the growth and preservation of the trees.

In addition to the natural forests there are many small wattle plantations in various districts where bark is produced for local tanneries. At the present time there are said to be 150,000 acres under black wattle in New South Wales. In 1924 a company was stated to have been formed and to have established a factory, near Merimbula, installed with modern machinery capable of a daily output of three tons of wattle bark extract.

There is a small export of tanning bark from New South Wales, ranging from 10,691 cwts. in 1920-21 to 199 cwts. in 1926-27, most of which is sent to New Zealand. The imports of wattle bark from South Africa, however, are greatly in excess of these figures, the maximum quantity in recent years being 48,587 cwts. in 1923-24.

Victoria.—The principal districts from which naturally grown wattle bark is obtained are the Dartmoor district on the Lower Glenelg, the Avenel, Seymour and Tallarook districts, the Briagolong and Glenmaggie districts in North Gippsland, and the Cunningham and Mitchell River districts in East Gippsland. The best bark is grown towards the west of Victoria, and it becomes less valuable near Gippsland. The Forest Department in 1913 had about 20,000 acres of natural wattle reserves, consisting chiefly of black wattle, mainly in the Victoria Valley and the Grampians, and also plantations made by the Department to the extent of about 5,000 acres of golden wattle. The chief Government plantations appear to have been at You Yangs, Havelock, Majorca and Kentbruck. There are also several privately-owned plantations in different parts of the State. The best-known plantation is that at You Yangs about thirty-five miles from Melbourne. It was established in 1887, and has been for some years the largest in Australia; it includes 2,000 acres of golden wattle.

The approximate area under black wattle in Victoria is now said to be 67,000 acres. Owing to the extension of cultivated and grazing land, however, the supply of bark in Victoria has for some years been unable to keep pace with the demand, and recourse has to be made to South African bark.

It is understood that the Commonwealth Government have installed a plant at the Government experimental station at Melbourne for the manufacture of wattle extract.

Queensland.—The black wattle is said to thrive in this State on the southern coast lands, on ranges inland and also on the vast western wooded plains. Formerly a fair amount of bark was harvested every year from the neighbourhood of Dalveen and from other districts, but attempts hitherto made to grow wattles on a commercial scale in Queensland for the sake of the bark have not

met with success. It is considered that the areas at present most suitable for the cultivation of *A. mollisima* are situated in the country between Warwick and the New South Wales border, and westward for 100 miles, and that some of the poorer country about Crow's Nest now used for grazing would prove suitable.

The following table shows the imports of wattle bark into Queensland from South Africa during the last five years for which official figures are available.

Imports of Wattle Bark into Queensland from South Africa.

	<i>Cwts.</i>	<i>£</i>
1921-22 . .	941	615
1922-23 . .	nil	—
1923-24 . .	2,919	1,343
1924-25 . .	200 ¹	93
1925-26 . .	1,610	804

¹ Including bark from British East Africa.

South Australia.—The wattle-growing area in 1924 was estimated by the Conservator of Forests to be over 135,000 acres, comprising an area of about 125,000 acres of golden wattle situated in the Mount Lofty Ranges, 10,000 acres of black wattle in the south-eastern part of the State, and smaller wattle areas in the Flinders Range. For some years there has been more or less systematic planting of golden wattle in the Adelaide Hills, where the trees are stated to reach their maximum value in about 7 to 9 years, when they yield from about 5 to 6 tons of bark per acre.

The following statistics show the amounts of wattle bark produced in South Australia during the last few years, and also their distribution :

Year.	Quantity.	Amount used in South Australian Tanneries.	Quantity exported to New Zealand.	Balance available for shipment	Total value.	Value per ton.			
						Tons.	£	s.	d.
1916-17 .	4,713	1,513	nil	3,190	—				
1917-18 .	4,223	1,437	252	2,534	—				
1918-19 .	4,959	1,399	nil	3,560	—				
1919-20 .	6,807	1,294	203	5,310	—				
1920-21 .	6,595	1,464	614	4,512	72,740	11	0	7	
1921-22 .	6,278	1,367	291	4,620	64,950	10	6	11	
1922-23 .	5,645	1,166	84	4,385	59,273	10	10	0	
1923-24 .	7,081	1,111	84	5,886	85,864	12	2	6	
1924-25 .	4,849	967	12	3,870	58,275	12	0	4	
1925-26 .	6,375	810	20	5,545	81,018	12	14	2	

Although *A. pycnantha* bark is one of the best tanning materials in the world, the industry makes no headway owing to the importation into Australia of South African wattle bark, practically the whole of which goes to Melbourne and Sydney, where it enters into keen competition with the South Australian product. It is stated that, even with the aid of the import duty of £3 per ton, the South Australian bark cannot be landed in Sydney as cheaply as the South African product.

Experiments have been carried out on the production of liquid extract from the "tops" of the golden wattle, consisting of the small branches, twigs and leaves, of which it is estimated there are 4 tons for every ton of air-dried bark. Such material has been found to contain about 17 per cent. of tannin on the moisture-free material. Two samples of such liquid extract made in the State contained 27·6 and 19·2 per cent. of tannin respectively.

Western Australia.—*A. mollissima* and *A. pycnantha* have been introduced to a limited extent into Western Australia. Experimental plantations have been made from time to time by the Woods and Forest Department with a view to encouraging settlers to plant portions of their holdings which are unsuitable for other crops. In 1922 *A. pycnantha* was sown by the Department in certain areas, amounting to 135 acres, on ground which appeared to be unsuitable for mallet. *A. pycnantha* has been found to develop rapidly on the better soils of the coastal plains, and on ironstone gravel in the Darling Ranges. At Balingup and in other districts there appear to be some very successful plantations, and the Forest Department are considering steps for the development of a systematic cultivation of wattles.

Tasmania.—The vast natural forests of black wattle in the island formerly provided the greater part of the wattle bark for export from the Commonwealth. In consequence, however, of the ruthless destruction of the trees for the bark, and the devastations caused by bush fires and grazing, the black wattle appears to have become nearly extirpated in much of the accessible wattle areas of Tasmania. Hence although Tasmania exported large quantities of wattle bark fifty years ago,

in 1912 only about 700 tons were exported from a total estimated production of about 2,897 tons, valued at £25,000. It was estimated in 1914 that there were still about a million acres of black and silver wattle in the State, mostly on privately owned land. The exports of wattle bark are not recorded separately in the official returns, but the following table shows the exports of "tanning bark" from Tasmania during some recent years. These figures presumably represent mostly wattle bark.

Exports of Tanning Bark from Tasmania

Year.	Quantity.		Value.	
	Oversea	Interstate.	Oversea.	Interstate.
1921-22	Cwts. 2,720	Cwts. —	£ 1,697	£ —
1922-23	Cwts. 3,241	Cwts. 49,981	£ 1,916	£ 23,558
1924-25	Cwts. 2,823	Cwts. 46,551	£ 1,475	£ 24,086
1925-26	Cwts. —	Cwts. 49,022	£ —	£ 26,646

It is stated that wattle trees in Tasmania are not properly ready for stripping until they are seven years old, though they are usually stripped when about five years old. No cultivation of wattle appears to have taken place in Tasmania.

Kenya Colony and Protectorate.—The experimental cultivation of the black wattle, *A. mollissima*, was undertaken in British East Africa (now Kenya Colony and Protectorate) about 1903 with a view to providing timber for use as fuel on the Uganda railway and steamboats.

Consideration was also given to the commercial possibilities of the bark for tanning, and a sample examined in 1908 was found to contain 43 per cent. of tannin. Several other samples which were forwarded to the Imperial Institute in 1910 for examination also proved to be of excellent quality, and showed that the bark would find a ready market in Europe (BULLETIN OF THE IMPERIAL INSTITUTE, 1910, 8, 249).

The encouraging results thus obtained led to a rapid extension of the area devoted to wattle. Early in 1911 nearly 3,000 acres were under cultivation, many of the trees being three years old and over, and by 1913 it was estimated that from 7,000 to 7,500 acres had been planted. In 1912, for the protection and regulation of

the industry, "The Wattle Bark Industry Ordinance" was enacted, a summary of which was given in the BULLETIN OF THE IMPERIAL INSTITUTE (1912, 10, 479). The present wattle-growing districts, situated in the Highlands of Kenya, are shown in the following table, together with the number of acres under wattle in each district on July 31, 1928. It will be seen from the corresponding total figures for 1925, given at the foot of the table, that the total area has increased somewhat in recent years. This was due in the main to the replanting that has taken place in the Kiambu district.

Total Acreage and Actual Production of Dried Wattle Bark during the Twelve Months ending July 31, 1928, in the Colony and Protectorate of Kenya.

	Total area on July 31, 1928 (not stripped of bark).	Area.		Actual pro- duction of dried bark between Aug 1, 1927, and July 31, 1928.
		Under 6 years of age	Over 6 years of age.	
<i>Kikuyu Province :</i>				
Fort Hall . . .	47	25	22	0
Kiambu . . .	5,393	4,639	754	41,160
Total . . .	5,440	4,664	776	41,160
<i>Nyanza Province :</i>				
Kavirondo Central . . .	2	2	0	0
Kavirondo South . . .	2	2	0	0
Kericho . . .	5	3	2	0
Total . . .	9	7	2	0
<i>Ukamba Province :</i>				
Kitui and Machakos . . .	1	1	0	0
Nairobi . . .	250	50	200	0
Teita . . .	5	0	5	0
Total . . .	256	51	205	0
<i>Extra Provincial Districts :</i>				
Kisumu-Londiani . . .	53	18	35	680
Naivasha . . .	35	10	25	1,200
Nakuru . . .	1,502	83	1,419	15,940
Nyeri . . .	98	71	27	0
Trans Nzoia . . .	355	283	72	0
Uasin Gishu . . .	2,174	1,132	1,042	0
Total . . .	4,217	1,597	2,620	17,820
Grand Total . . .	9,922	6,319	3,603	58,980
Corresponding figures, 1925	8,830	2,803	6,027	62,340

The following table shows the exports of wattle bark from Kenya from the year 1910-11, when the first 10 tons were exported, to 1927. During the war the export of bark practically ceased, owing to the lack of shipping and other circumstances. In the years following the cessation of hostilities the industry was faced with the difficulty of high freights, and only in recent years has the export been again remunerative. The diminution in the exports of bark since 1924 is due to a great extent to the employment of the bark in Kenya for the production of extract.

Exports of Wattle Bark from Kenya Colony and Protectorate

Year.	United Kingdom. Cwts.	Germany. Cwts.	Total. Cwts.	Value. £
1910-11	. . 200	—	200	47
1911-12	. . —	860	860	333
1912-13	. . 640	400	1,040	508
1913-14	. . 1,600	2,420	4,040 (a)	1,917
1914-15	. . —	540	540	237
1915-16	. . —	—	—	—
1916-17	. . —	—	—	—
1917-18	. . (b)	—	(b)	10
1918-19	. . 124	—	124	32
1920	. . (b)	(b)	9,025	6,780
1921	. . —	—	—	—
1922	. . 580	(b)	9,414	2,708
1923	. . 6,360	(b)	17,794	5,836
1924	. . 3,038	(b)	71,416	17,901
1925	. . 27,384	(b)	62,817	19,669
1926	. . 17,076	7,492	36,537	13,702
1927	. . 14,794	21,396	44,083	17,338

(a) 20 cwts. to France. (b) Information not available.

The increasing demand for wattle extract and the desire to obtain a more remunerative industry led to the establishment in 1923 of an extract factory in Kenya, and the following amounts of extract have since been exported :

		Cwts.	£
1925	. .	9,203	5,163
1926	. .	12,396	11,156
1927	. .	21,230	19,188

This extract plant, which is situated at Limoru, was considerably enlarged in 1926, and its output in 1928 amounted to something over 100 tons of wattle extract per month. Tentative plans have now been put forward

for the erection of a second factory at Kikuyu to produce approximately double the above figure. The cultural conditions for wattle in Kenya have proved more favourable than in Natal, the trees reaching maturity at an earlier age and furnishing from 5 to 6 tons of bark per acre as compared with about 4 tons in Natal. Under the best conditions, the first stripping of the bark can be effected either in the fourth to the fifth year, or else in the fifth to the sixth year, when the trees should be 6 to 8 in. in diameter and 90 ft. high. In Natal, on the other hand, the trees must attain an age of seven or eight years before the bark is sufficiently matured to give the best results ; they then have an average diameter of only about 5 to 6 in. Moreover, Kenya wattle bark contains a higher average percentage of tannin than Natal bark. The examination of a large number of samples of Kenya wattle bark at the Imperial Institute showed an average tannin content of 37 per cent. On the other hand, Kenya is at a disadvantage as compared with Natal in not having a ready local market for the wood. The industry too is not so highly organised ; some of the bark is badly harvested, and this inferior bark tends to keep the price of the Kenya produce below that of Natal bark.

Tanganyika.—During the German occupation the black wattle was cultivated successfully from seed obtained both from Natal and Australia, and as early as 1904 plantations laid down principally in the neighbourhood of West Usambara furnished bark of satisfactory quality. Two small consignments, each of about one ton, sent to Hamburg in 1909 contained 40 and 33 per cent. of tannin respectively. Plantations of *A. mollissima* and *A. decurrens* var. *normalis* were also made at Wilhelmstal, and several samples of bark, taken from trees of each variety, gave an average of 44 per cent. of tannin for the former and 38 per cent. for the latter. In 1925 the Forest Department decided to raise seedlings and plant up a new wattle plantation at Amani to replace the existing plantation which appeared to have suffered through neglect.

India.—In addition to about eighteen species of indigenous acacias, India possesses also the Australian species, *A. mollissima* (black wattle) and *A. dealbata* (silver wattle), which were introduced on the Nilgiri Hills in the early forties of the last century and have become established. At altitudes above 7,000 ft. only the black wattle, which is by far the less plentiful of the two, is found, whilst at the lower elevations the silver wattle occurs in increasing numbers. These two species appear to have been introduced mainly with the object of providing fuel, of which there was a shortage at that time, and although the bark appears to have been employed locally to some extent for tanning, it is only within recent years that the valuable tanning properties of the black wattle bark have been realised by planters, and that any serious attempt has been made to cultivate the tree. A report received from the Director of Agriculture in Madras in 1925 stated that the Forest Department had during the last few years been planting black wattle round the pine plantations at Kodaikanal as a fire belt, but that no large-scale cultivation had been undertaken by the Government. Several small privately owned plantations now exist, but the supply of bark is small and insufficient for the local demand, and considerable quantities of wattle bark are therefore imported from Natal. The South African product appears to have first been employed in India in 1915; the quantities subsequently consumed, according to the Indian official returns, are shown in the following table :

Indian Imports of Natal Bark

	Cwts.		Cwts.
1915-16 . . .	25,952	1922-23 . . .	9,440
1916-17 . . .	35,433	1923-24 . . .	11,685
1917-18 . . .	55,366	1924-25 . . .	21,392
1918-19 . . .	20,731	1925-26 . . .	96,077
1919-20 . . .	57,738	1926-27 . . .	116,735
1920-21 . . .	41,934	1927-28 . . .	176,615
1921-22 . . .	23,603		

Samples of bark from plantations in Madras and Travancore were examined at the Imperial Institute in 1925 with the following results :

		Per cent.	Per cent.	Per cent.	Per cent.
		Madras.		Travancore.	
Moisture		10.8	10.4	9.4	9.2
Insoluble matter		32.4	44.3	42.2	45.4
Extractive matter (non-tannin)	10.0		9.9	10.2	8.3
Tannin		46.8	35.4	38.2	37.1
Ash		2.3	2.4	2.0	2.5

Tintometer readings :

Red		5.2	4.1	3.1	4.3
Yellow		5.0	6.2	4.2	5.4

The bark is thus of good quality and compares very well with the South African product. In view of the local demand there is every prospect that the wattle plantations in Southern India will be extended, but consignments for export will not be available until the production has considerably increased. The question of freight will then be an important factor in competition with Natal bark.

As a result of enquiries specially made by the Imperial Institute, it appears that the wattle tree does not occur in Burma, and it is doubtful whether the soil and climate are suitable for its growth. It would be difficult to arrange either the skilled supervision necessary for the introduction of a new tree, or the supply of cheap and efficient labour which would be required. It therefore appears unlikely that wattle cultivation could be successfully undertaken in Burma.

Ceylon.—The black wattle, *A. mollissima*, was introduced into Ceylon over thirty-five years ago, and cultivated in the Hakgala Botanic Gardens. Trees are now found scattered over the tea estates, and are also grown in blocks for firewood. The tree thrives in suitable situations, and provides bark of good quality, which is used in local tanneries.

In connection with enquiries made by the Imperial Institute in several parts of the Empire a few years ago with a view to the extension of wattle cultivation, samples of bark from trees growing in the Hakgala gardens were received for examination in 1923. The samples contained 27.5 to 33.6 per cent. of tannin and produced leather with the usual characteristics of wattle-tanned leather (*BULLETIN OF THE IMPERIAL INSTITUTE*, 1923, 10, 466).

A trial consignment of $11\frac{1}{4}$ tons of bark was shipped to the United Kingdom in 1924. The material realised the current market price of wattle bark, but the profit on the entire consignment was only £5 13s. 5d., owing to the heavy railway charges and ocean freight which together amounted to over £5 per ton, or about twice as much as the corresponding charges on bark from South Africa at that time. Hence, although wattle bark of good quality can be produced in Ceylon, the transport charges are at present too high to make the export of the bark remunerative.

Nyasaland.—It is understood that the cultivation of black wattle has been attempted in Nyasaland, but without success, owing to the lack of moisture for many months of the year. There are areas where wattle might succeed, but these are very limited, and it does not appear worth attention as an economic crop. Further, railway and ocean freights from Nyasaland to the United Kingdom are too high to allow bark produced in Nyasaland to compete with Natal bark.

Seychelles.—A sample of bark from trees grown in Seychelles has been examined at the Imperial Institute. It was paler in colour and of rather different appearance from the black wattle bark of Natal and East Africa, and was found to contain only 12 per cent. of tannin. Such bark would not be suitable for the British market.

West Indies.—The Commissioner of Agriculture for the West Indies has informed the Imperial Institute that the possibility of wattle cultivation in the West Indies had received some attention, but the prospects did not appear to be attractive.

MANGROVE BARK

The name "mangrove" is applied to a number of trees, most of which belong to the Natural Order *Rhizophoraceae*. These trees or shrubs inhabit the muddy swamps close to the seashore, and at the mouths of the rivers in tropical countries, where they frequently form

forests of vast extent. Mangroves are noted for their abundance, wide distribution and rapid growth. They are found distributed widely throughout the tropics, viz. in India, Indo-China, Federated Malay States, Philippine Islands, Borneo ; West and East Africa ; Madagascar ; Australia, Papua and New Caledonia ; on the southern coasts of the United States of America ; in Central America, and on the northern shores of South America.

All parts of the trees contain tannin, but it is only the bark that, from a commercial standpoint, contains sufficient of this constituent. The mangroves best known as yielding bark suitable for tanning purposes are : *Rhizophora mucronata* Lam., and *R. Mangle* Linn. ; *Bruguiera gymnorhiza* Lam. ; *Ceriops Candolleana* Arn., and *C. Roxburghiana* Arn. ; *Kandelia Rheedii* Wight and Arn. Other forms of mangrove include *Carapa moluccensis* Lam. (= *Xylocarpus granatum* Koen.) ; *Ceriops Tagal* Robinson ; *Rhizophora conjugata* Linn. ; *Bruguiera eriopetala* Wight and Arn. and *B. parviflora* Wight and Arn., and *B. Rheedii* Blume ; *Heritiera* spp. ; and *Avicennia officinalis* Linn.

It has been frequently proved that the percentage of tannin in the bark of the same variety of mangrove is not constant, but varies according to the locality in which the tree grows. This variation is illustrated by the following results recorded for the bark of *Rhizophora mucronata* :

Country of Origin.	Tannin. Per cent.
Malaya	30 to 40
Tanganyika Territory	36.5
India, Sundarbans	35.0
South America	30.0
Philippine Islands	27.6
Borneo	20.5

It will therefore be seen that it is impossible to state for each variety a definite figure for the percentage of tannin generally present in its bark.

Although, as has been shown from investigations carried out on barks from Tanganyika Territory, the percentage of tannin in the bark does not vary according

to the age of the tree or the season of the year in which it was stripped, yet with some varieties, e.g. *Rhizophora mucronata* and *Bruguiera gymnorhiza*, it is recommended that the material should be collected at the end of the year, as the leather yielded by such bark is of lighter colour and not so red as that prepared from material stripped at other times. This feature is of importance because mangrove bark has the disadvantage of imparting to leather a dark red colour. On this account its general use has been somewhat restricted. Apart from this defect, mangrove-tanned leather, when properly made, is of fair quality and suitable for shoe leather and for similar purposes.

The use of mangrove bark in British tanneries is of comparatively recent date. Prior to 1914 exports seem to have been sent principally to Germany, the United States and Russia, while only small quantities were imported into the United Kingdom. Since the war, however, the use of this tanning material has been on the increase in this country. It has been found that, when used in admixture with other materials, it can be successfully employed, and it is therefore usually blended with pine, oak or wattle.

Mangrove bark intended for export should contain at least 30 per cent. of tannin, and in this connection it is interesting to note that, when Tanganyika Territory formed part of the German Empire, no mangrove bark was allowed to be exported containing less than 45 per cent. of tannin. In many countries, however, the mangrove bark does not contain as much as 30 per cent. of tannin, and, in this case, if it is desired to create an overseas trade in the material, the bark has to be converted into an extract or "cutch," the preparation being carried out according to the usual method employed for the manufacture of tanning extracts. It should be emphasised that before concentration the aqueous extract should be decolourised to give a high-grade product. Decolourisation, however, is not so readily effected in the case of mangrove bark as with other extracts. Nascent hydrogen is stated to be the most successful bleaching agent. The addition of alum, or

barium aluminate and a sulphate, also gives good results, but the use of these reagents entails a certain loss of tannin.

Bark intended for export should, after being stripped from the living or dead trees, be dried as soon as possible, care being taken that it is not unnecessarily exposed to rain, as this incurs a loss of tannin. The drying is effected either in the sun or by artificial heat. The dried bark is baled for export, in some cases under pressure. Occasionally the bark is roughly ground before being bagged for export.

As far as the British Empire is concerned, varieties of mangroves occur abundantly in a considerable number of countries, notably in British East Africa, British North Borneo, India, Australia, British West Africa and the Federated Malay States.

British East Africa.—Mangrove bark from Tanganyika Territory and Kenya represents, on the whole, the richest in tannin of any obtained within the Empire. That found in the former country has been exploited for a considerable number of years, and a large trade was carried on by the Germans prior to 1914. Apparently, however, the trade dwindled to very small dimensions, for in 1923 only $7\frac{1}{2}$ tons were exported. Since then, however, the exports have steadily increased as shown in the following table.

Year.	Quantity.		Year.	Quantity.	
	Tons			Tons	
1924	.	205	1926	.	6,209
1925	.	2,945	1927	.	8,330

Most of the bark was shipped to Germany, except in 1927, when over 6,000 tons went to the United States.

The different varieties of mangroves found in Tanganyika Territory were investigated nearly thirty years ago. The chief varieties occurring there are *Rhizophora mucronata*, containing up to 48 per cent. of tannin; *Bruguiera gymnorhiza*, with from 28 to 53 per cent.; *Ceriops Candolleana*, with 24 to 42 per cent., and *Carapa moluccensis*, with 27 to 40 per cent. Concessions are granted in this country as in others for the exploitation of the mangrove forests.

The following table shows the exports from Kenya and Uganda :

Year.	Quantity. Tons.	Year.	Quantity. Tons.
1913-14 . .	8,062	1918-19 . .	150
1914-15 . .	3,049	1919-20 . .	900
1915-16 . .	3,012	1920-21 . .	25
1916-17 . .	737	1926 . .	261
1917-18 . .	308	1927 . .	158

During the years 1922-25 the exports of mangrove bark were not recorded separately.

In Zanzibar and Pemba mangrove trees are abundant in the creeks, and especially throughout Pemba. Samples of the barks have been examined at the Imperial Institute and gave the following results (*BULLETIN OF THE IMPERIAL INSTITUTE*, 1904, 2, 163) :

		Tannin. Per cent.
Zanzibar		35.8
Pemba		23 to 34

It will be noted that these samples are not quite so rich as those from Tanganyika Territory.

British North Borneo.—Another part of the Empire which exploits the mangrove forests for export is British North Borneo. Whereas in British East Africa the bark itself is shipped, in North Borneo the trade is almost, if not entirely, confined to mangrove "cutch," as the bark is not sufficiently rich in tannin to render its export profitable.

The mangrove forests occupy large areas in this part of the Island and are mostly found on the east coast. The chief varieties are *Rhizophora conjugata*, *R. mucronata*, *Ceriops Tagal*, *Bruguiera eriopetala* and *B. gymnorhiza*. The bark from these varieties contains from 25 to 35 per cent. of tannin.

The manufacture of mangrove cutch is a well-organised and old-established industry in the country, and has assumed great importance. With the increased use of mangrove by the tanning industry in the United Kingdom, the exports of the cutch to the home country have grown larger.

Federated Malay States.—Large areas of mangroves exist in the Federated Malay States, there being 250 square miles of mangrove forests on the coast of Perak and Selangor. The chief species, with the percentage of tannin in the bark, so far as analyses have been published, are as follows : *Rhizophora mucronata* (29.1–35.3 per cent.), *R. conjugata* (10.4 per cent.), *Avicennia officinalis*, *Bruguiera gymnorhiza* (24.1 per cent.), *B. eriopetala* and *Ceriops Candolleana* (31.6–42.6 per cent.). The mangrove forests are largely exploited as a source of firewood, but the bark is utilised for the manufacture of cutch on only a small scale for local use ; the bark of *Ceriops Candolleana* is preferred by the natives for the latter purpose, but this species is not available in large quantities.

In the years 1923–27 the following quantities were exported from British Malaya, most of which went to Hong Kong and China :

Year.	Tons	Year.	Tons
1923	. . 11,601	1926	. . 10,150
1924	. . 8,397	1927	. . 6,997
1925	. . 9,087		

India.—Abundant supplies of mangrove bark are available in many parts of India. The principal mangrove areas are the Sundarbans, the delta forests of the Irrawaddy, on the Arakan coast, in Mergui and Tavoy, and in South-East Madras. Although large quantities of the bark are available, up to the present its use has been confined to local tanneries.

The principal species occurring in India are *Rhizophora conjugata*, *R. mucronata*, *Heritiera Fomes* Buch.-Ham. (= *H. minor* Roxb.), *Ceriops Candolleana*, *C. Roxburghiana*, *Carapa* spp., *Bruguiera* spp. and *Sonneratia* spp.

The forests of the Sundarbans and of South Tenasserim have been investigated with a view to the exploitation of the bark of the mangrove trees. In the former district the commonest varieties are :

					Tannin. Per cent.
<i>Heritiera Fomes</i>	.	.	.	.	10
<i>Ceriops Roxburghiana</i>	.	.	.	.	37
<i>Excoecaria Agallocha</i> Linn.	.	.	.	.	10
<i>Sonneratia apetala</i> Buch.-Ham.	.	.	.	.	14

while in South Tenasserim the following are the most abundant varieties :

	Tannin. Per cent.
<i>Rhizophora mucronata</i>	45
<i>R. conjugata</i>	36
<i>Carapa moluccensis</i>	27
<i>Ceriops Candolleana</i>	41
<i>Bruguiera gymnorhiza</i>	42

As regards the Sundarbans it is recommended that the barks of *Heritiera Fomes* and *Ceriops Roxburghiana* should be utilised commercially for the manufacture of tanning extracts.

Samples of Indian mangrove bark have from time to time been examined at the Imperial Institute, and the analyses have shown them to contain from 4 to 27 per cent. of tannin, a content considerably less than most of those quoted above.

Mangrove bark from India is, on the whole, less rich in tannin and therefore less suitable for export than that from East Africa. Trials have been made to determine the suitability of Indian barks for the preparation of extracts. Samples of such extracts have been examined at the Imperial Institute and shown to be of inferior quality. There can, however, be but little doubt that mangrove extract of good quality can be prepared from several varieties of Indian bark.

For many years the Indian Government maintained an experimental factory for the manufacture of mangrove extract in Rangoon. It was, however, closed down in 1905, as it was not a success. Nevertheless, in spite of this reverse, the best method of developing an export trade in Indian mangrove barks appears to be to manufacture extract for shipment.

Queensland.—As far as Australasia is concerned the mangrove forests that have received the most attention are those of Queensland and Papua. Several samples of bark from North Queensland have been found to contain about 39 per cent. of tannin. The most common mangroves found in the area from Murray River to Point Cooper (4,600 acres) are *Rhizophora mucronata* (27 to 36 per

cent. of tannin) and *Bruguiera Rheedii* Blume (13 to 20 per cent. of tannin). These two varieties together represent about half of the mangroves occurring there. Two other varieties are fairly common, viz. *Bruguiera parviflora* (5 to 10 per cent. of tannin) and *Ceriops Candolleana* (21 to 26 per cent. of tannin). A number of concessions have been granted from time to time, but an export trade does not yet appear to have been created. With a view to stimulating the use of the material, a Committee was appointed by the Institute of Science and Industry to investigate the decolourisation of mangrove extracts. They, however, were not successful in reducing the colour of the extract, but did succeed in preparing from Queensland bark a lighter coloured leather.

It appears very doubtful whether by using white labour to strip and handle the bark, Australia can compete with countries where cheap black labour is available and where extracts are now being manufactured. It is not likely that mangrove bark will be used in this continent for tanning leather other than sole leather as long as tanners can get wattle bark and extracts.

Papua.—Abundant supplies of mangrove bark are available in Papua. The chief varieties occurring in this country are *Bruguiera Rheedii*, *Rhizophora mucronata* and *Carapa moluccensis*, the barks of which contain 31, 18 and 24 per cent. of tannin respectively. Large quantities are stated to have been shipped to Australia in 1917, but efforts to develop a regular industry have so far not proved successful, the cause of the failure being ascribed to a lack of capital or of knowledge.

British West Africa.—Although mangroves abound in West Africa, they have not been exploited to the same extent as in East Africa. Furthermore, the West African bark is not so rich in tannin as that from the other side of Africa. Samples from Sierra Leone, Gambia and the Gold Coast examined at the Imperial Institute have been found to contain up to 28 per cent. of tannin (BULLETIN OF THE IMPERIAL INSTITUTE, 1907, 5, 343; 1913, 11, 415; 1921, 19, 147).

Small shipments of mangrove bark from Sierra Leone.

containing 18 per cent. of tannin, were offered on the market some years ago, but, as could only be expected with bark of this low tannin content, they were unsaleable.

Mangrove bark is used locally in West Africa for tanning purposes, but there appears to be no export trade in it.

Other Countries.—Besides the countries already mentioned, mangroves are also found in Seychelles, Fiji, Bahamas, British Honduras, British Guiana and Trinidad.

Aldabra Island is the only island in Seychelles which produces mangroves. Samples of the bark were examined at the Imperial Institute with the following results (*BULLETIN OF THE IMPERIAL INSTITUTE*, 1907, 5, 343) :

	Tannin.	Per cent.
<i>Rhizophora mucronata</i>	25 to 35	
<i>Bruguiera gymnorhiza</i>	42 to 45	
<i>Ceriops Candolleana</i>	35	
<i>Pemphis acidula</i> Forst. . . .	43	

Small consignments of the Seychelles bark are reported to have been sold.

From Fiji samples of extract were received and examined at the Imperial Institute (*BULLETIN OF THE IMPERIAL INSTITUTE*, 1913, 11, 418), and contained 60 to 70 per cent. of tannin. These trials showed that good extract could be prepared in Fiji, but that it must be decolourised before concentration.

In the Bahamas *Avicennia nitida* Jacq. is the most common variety.

Samples of *Rhizophora Mangle* bark from British Honduras and British Guiana have also been examined at the Imperial Institute, and found to contain 5 to 20 and 25 per cent. of tannin respectively (*BULLETIN OF THE IMPERIAL INSTITUTE*, 1907, 5, 343).

Mangroves grow abundantly in Trinidad ; a sample of the bark examined at the Imperial Institute was found to contain 22.0 per cent. of tannin and 8.0 per cent. of extractive matter (non-tannin).

Conclusions.—The above review of the mangrove forests of the British Empire demonstrates that there are large supplies of mangrove barks available for commercial exploitation. With the exception of East Africa, British

North Borneo and the Federated Malay States, none of the countries appears to engage in the exportation of either the bark or extract.

The most suitable method for exploiting the mangroves in the majority of these countries appears to be to manufacture an extract of good quality for export. For this, as for the bark itself, there appears to be a growing market, as mangrove is calculated to be the cheapest tanning material per unit of tannin, and has also rapid penetrating powers which are conducive to quick tannage.

MALLET BARK

This material, which is one of the world's richest tan barks, is derived from the brown mallet tree, *Eucalyptus occidentalis* Endl. var. *astringens* Maiden. The source of supply is Western Australia, where the tree is known locally as the "flat-topped yate." It occurs over a comparatively narrow strip of country on the west side of the York-Albany railway line, and over a strip, 150 miles in width, on the east side of the line. The tree reaches an average height of 60 to 80 ft., and is covered with a black outer cortical layer which contains only 9 to 14 per cent. of tannin. This outer bark is removed, and the inner bark, bright yellow to dark brown in colour, is sent into commerce in pieces varying from 2 to 12 in. in length. The average composition of mallet bark is as follows :

	Per cent.
Moisture	14·5
Tannin	42·0
Extractive matter (non-tannin)	8·0
Insoluble matter	35·5

The tannin content varies from 31 to as much as 52 per cent., and the non-tannin extractive matter from 5 to 10 per cent. According to Paessler, the sugars present amount to 2·2 per cent., which corresponds to about 5 parts of sugars to 100 parts of tannin. The tannin belongs to the catechol group. It is easily leached with cold water, 90 to 95 per cent. of the tannin being extracted, as compared with 50 to 60 per cent. from quebracho. The use of warm water increases the amount of tannin extracted

from the bark, and the operation can be satisfactorily performed at 60° C. The liquor so obtained is strong and clear, and no deposit collects on cooling or long standing. Mallet bark has been found to be an excellent tanning agent. Calf skins tanned with it produce leather of normal quality throughout, the colour being light and regular. The leather possesses a fine, uniform grain, a smooth flesh side, and is very tough. The leather produced by the sole use of mallet bark has an orange tint, but this can be obviated by using other tanning materials in conjunction with it. An unsatisfactory feature of mallet bark tannage is the tendency of the leather to darken on exposure to light and to assume a reddish tint. The bark is also successfully used for tanning hides. In consequence of the low content of non-tannin extractive matter, only a small amount of acid is formed in mallet bark liquors by fermentation, and, in order to induce swelling, other tanning agents rich in sugary matter must be included in the tannage or the deficiency overcome by the addition of lactic or acetic acid.

The mallet bark industry of Western Australia has suffered through excessive exploitation. Prior to 1903 the value of the bark had not been fully recognised, but apparently in that year its commercial possibilities were discovered and the rapid development of the export trade commenced (see BULLETIN OF THE IMPERIAL INSTITUTE, 1905, 3, 69 ; 1908, 6, 318 ; 1911, 9, 179). The qualities of the bark were quickly appreciated in Germany, and a large demand arose. By 1905 the exports to countries outside Australia had risen to nearly 16,000 tons, with a total value of £120,000, of which over 15,000 tons were sent to Germany. From that date, however, the overseas exports steadily decreased, dropping to less than 5,000 tons in 1913 and almost disappearing in the period between 1920 and 1923. The shipments to other States of the Commonwealth have remained fairly constant in recent years.

The following table shows the exports of "tan bark" from Western Australia during various years since 1905. The figures may include small quantities of bark other than mallet bark. Except during and immediately after

the war, Germany throughout the period covered by the table was the chief overseas customer for the bark.

Year.	Exports to countries outside Australia.		Exports to other States of the Commonwealth.		Total.	
	Quantity	Value.	Quantity.	Value	Quantity.	Value
1905 .	318,315	119,855	96,003	34,232	414,318	154,087
1913 .	92,488	37,336	23,910	10,041	116,398	47,377
1916-17 .	11,704	5,302	31,399	13,657	43,103	18,959
1918-19 .	1,221	860	38,928	18,015	40,149	18,875
1920-21 .	367	202	41,279	22,871	41,646	23,073
1924-25 .	38,333	20,727	35,242	19,409	73,575	40,136
1925-26 .	5,440	3,117	21,760	11,939	27,200	15,056
1926-27 .	4,100	2,544	24,982	13,274	29,082	15,818
1927-28 .	15,867	10,315	28,892	17,347	44,759	27,662

The cause of the decline in the total output of bark was the indiscriminate destruction of the mallet forests, which took place when the value of the bark became known. The Western Australian Government drew up regulations restricting the cutting of the trees, but not before great damage had been done, and it would appear that the regulations were not strictly enforced. The depletion of the resources has affected not only Europe, but the tanneries of the eastern states in Australia, where anxiety is being felt regarding the maintenance of supplies. In recent years mallet has been so scarce in its original habitat that exporters of bark have obtained their material from young saplings, which have been stripped standing. To prevent the continuance of this dangerous practice, and the extinction of the species which would eventually follow, the Forests Department have recently taken steps to enforce the existing regulations, and it is hoped that the regeneration of the mallet forests will be achieved in due course. A preliminary survey has disclosed the existence of considerable areas of dense re-growth on poor rocky hill-tops. The protection and extension of these areas of new growth on land that is unsuitable for other purposes are likely to prove a profitable undertaking to the State; certain reserves have already been created and sylvicultural work commenced.

The commercial mallet bark as exported from Western Australia has frequently been a mixture of the bark of

the brown mallet with the barks of the following mallets, which are of less value.

White Mallet (*Eucalyptus falcata* Turcz. var. *ecostata* Maiden). The air-dry bark contains about 30 per cent. of tannin. The tree occurs scattered in mallet patches.

Blue Mallet (*E. Gardneri* Maiden). The tree occurs in close formation on patches of limited extent. The average tannin content of the air-dry bark is 26 per cent.

Swamp Mallet (*E. spathulata* Hook.). This tree occurs in scattered patches in the south-west corner of the savannah forests, and its bark in air-dry condition contains about 26 per cent. of tannin.

In 1905, when the export of mallet bark to Europe was at its height, the threat to the trade in wattle bark was realised in South Africa, and the cultivation of the mallet tree in that country, especially in the south-west district of Cape Province, was considered. As it was apparent, however, that the exports of mallet bark from Australia could not be maintained on a scale at all approaching that of 1905, the anxiety passed and no steps of any importance were taken. At the same time Germany anticipated a diminution of supplies, and the introduction of the tree into German colonies was contemplated, but there is no evidence that such a scheme was carried into effect.

HEMLOCK BARK

This tanning material, derived from the hemlock spruce tree, is of great importance in Canada and in the United States, and is imported into the United Kingdom from the former country. There are three species of hemlock in the Canadian forests, two of which are of interest in the present connection. These are (1) the Eastern hemlock, *Tsuga canadensis* Carr., and (2) the Western hemlock, *Tsuga heterophylla* Carr. The former is found from Nova Scotia westward throughout the St. Lawrence river valley and Ontario to the west end of Lake Superior, but does not occur west of this district, while the latter is practically confined to British Columbia. It is the eastern hemlock which has played so great a part in the tanning industries of Canada and the United States.

the utilisation of the western hemlock being still in its infancy. Eastern hemlock at one time was felled only for the purpose of stripping the bark, and the logs were left to burn or rot in the forests. To-day hemlock wood is more valuable than the bark, and the tree occupies fourth place as a lumber producer in Canada, with an average annual cut of about 250 million feet board measure. The eastern hemlock forms approximately 85 per cent. of this lumber, and the remainder is cut mostly from the western hemlock. This figure gives indirectly an indication of the abundant resources of hemlock bark in Eastern Canada. Eastern hemlock bark contains from 8 to 10 per cent. of tannin, which belongs to the catechol group, and the material is generally employed in the form of extract. For this purpose the trees are cut down and the bark immediately stripped off. The bark is then allowed to lie with the inner side uppermost until comparatively dry, when it is piled ready for removal to the factories. It forms one of the principal tanning materials used in Canada, not only for the red hemlock sole leather, but in combination with other tans or alum for a large proportion of the exported dressing leather. An extract of the bark is exported, but the quantities have decreased during the last few years. The United Kingdom has been the chief consumer of the exported extract, but of late years it has not been used in this country to any large extent. The decline is attributable to the preference British tanners show for other materials, when the latter are obtainable at a satisfactory price.

Hemlock Extract

Value in \$ of Exports from Canada.

Years ending March 31.

	1922.	1923.	1924.	1925.	1926.	1927.	1928.
United Kingdom .	28,868	19,623	1,580	—	—	—	—
Newfoundland .	2,967	1,971	1,300	736	2,457	1,342	1,875
United States .	15,109	4,578	30	84	—	—	83
Other countries .	—	—	—	393	—	—	—
Total .	46,944	26,172	2,910	1,213	2,457	1,342	1,958

The bark of western hemlock contains 10 to 12 per cent. of tannin. The quantities of this bark available in British Columbia are very extensive, but are mostly wasted owing to the methods of lumbering. In Eastern Canada there is a steady demand for hemlock bark, and its production is an important adjunct to the lumber industry, the peeling of the logs in the forest forming a remunerative operation. In British Columbia, however, the hemlock logs with bark attached are floated to the mills for the production of timber, where the bark is discarded. A small amount, sufficient for the requirements of the tanneries of the Pacific coast, is utilised, but the export of the bark is prohibited by the cost of transport. In the United States the western hemlock is found along the coast ranges through Washington and Oregon to Northern California, and is stated to be used in several western tanneries.

AVARAM BARK

Avaram bark, also known as Turwad, Avla and Tanners' Cassia, is the most important tan-bark of India. It is obtained from *Cassia auriculata* Linn., a bush which grows wild in the south and west of India, covering large areas in the Deccan. It is also found in the dry zone of Upper Burma. The right of collecting the bark from Government forests in India has for years been granted on contract by the Forest Department, and the contracts are usually put up to auction. The bark is, however, much more plentiful outside reserve forests, occurring on most village lands. The method of collection consists in cutting off at the base branches and twigs which spring from the root. The coppiced bush sends out a large number of shoots, and a new harvest can be taken after a year. The stripped bark dries in small cornets, and the product usually delivered to the tanneries contains on an average about 18 per cent. of tannin and 10 per cent. of soluble non-tans. Analyses conducted at the Imperial Institute and elsewhere have shown that the bark from old plants may contain as much as 23 per cent. of tannin, while that from young plants may contain only 12 per cent. or even less. The soluble non-tannin matter may be as high as 14 per cent.

The use of the bark is confined to Southern India, where in the past it has been the principal tanning material used in the preparation of East India tanned hides and of tanned goat and sheep skins. The greater part of the collected bark is consumed in Madras, where the production of tanned hides and skins for export is chiefly located. The amount of bark collected in Madras provides only a part of the local requirements, two-thirds of the total quantity employed being obtained from Mysore and Hyderabad.

The success of the tanning industry in Madras is regarded as almost entirely due to the peculiar qualities of avaram bark and to the fact that supplies in the past have been available at a low price. It produces a special form of leather, lightly tanned, with an elastic grain, of a pale colour and with good tensile strength. This half-tanned leather, known as East Indian tanned hides, is exported to the United Kingdom, where its tannage and preparation for a variety of uses are completed. The special feature of avaram bark is that it is very easy to use, and in spite of the carelessness which often obtains in its application by native tanners, it yields uniformly successful results. During the war the enormous demand for the bark, consequent upon the increased output of South Indian tanneries, caused many areas to be stripped in such a way that the supply was seriously affected, and great anxiety was manifested as to the renewal of regular supplies. In 1918 the consumption in the tanneries making war leather was estimated at 80,000 maunds per month. The average price paid for avaram bark before the war was Rs. 3 per maund ; during the war the price ranged from Rs. 5 to Rs. 15. The importance of establishing plantations of avaram was recognised, and experiments were carried out on its cultivation in the Bombay Presidency (including Sind), the United Provinces, Madras and Burma from 1916 to 1921. In the United Provinces and in Sind the climate proved to be unsuitable. In Madras the experimental raising of seedlings, which had proved troublesome in the earlier attempts at cultivation, was brought to a successful issue, but the cultivation was nowhere taken up to any extent. The cost of agricultural

land and of labour is high, and it has not yet been shown that the cultivation of avaram would be a commercial success. With regard to departmental experiments, it would appear that about 1921, when a comparative falling-off in the demand for avaram had taken place owing to the termination of the market for war materials and to the large stocks of leather on hand, it was not thought advisable to incur further expenditure, and the matter was allowed to lapse.

At the present time it is considered that the wild avaram bark available for collection is sufficient to meet the requirements of the industry. The cost of labour, however, has increased to such an extent that the price of avaram bark has consistently risen, reaching as much as Rs. 45 per maund in 1926. The price obtained for the tanned hides does not permit of the employment of avaram at its present high cost as the principal tanning agent. Other tanning materials have been largely substituted, but these have so far failed to produce such satisfactory effects as the avaram bark to which the Madras tanner has for so long been accustomed.

BABUL BARK

The bark of the tree *Acacia arabica* Willd., known as babul bark, constitutes the most important tanning material of Northern India. The tree is indigenous to Sind, Rajputana, Berar and the Central Provinces, Gujarat, and the Northern Deccan, but it is also cultivated and grown throughout the drier parts of India, and to a small extent in Upper Burma. The babul forests are situated in Bombay (including Sind), Berar (Central Provinces) and Madras. The largest forests are found in Sind, in the Hyderabad and Jerruck Divisions of which province they cover 170,000 acres. In many parts of India the babul occurs only in the form of small patches of isolated trees.

The bark is largely used in small village tanneries throughout Northern India, and is the principal material used in the leather industry of Cawnpore. In 1919 it was stated that over 500,000 maunds of bark were being consumed in the great tanneries of that city. The bark supplies in the immediate neighbourhood of Cawnpore

have been practically worked out, but abundant quantities are available within easy reach, and the cost of the bark remains relatively low as compared with that of avaram bark in Madras. The tannin present in the bark varies considerably and may attain to 20 per cent., but the average content of the bark delivered to the tanneries is about 12 per cent., while the soluble non-tans amount to about 8 per cent. The leather made from babul bark possesses firmness and durability to a high degree, but exhibits harshness and is dark-coloured. The Cawnpore industry produces a finished leather for home use in the tannage of which myrobalans also enter. Babul bark is not suitable for the production of half-tanned hides such as are produced in Madras by means of avaram bark. Leather produced by the former bark does not lend itself readily to re-tanning to meet the various requirements of the United Kingdom market, and consequently Cawnpore, though situated in the centre of the best hide-producing area in India, does not participate in the export trade of half-tans. Avaram bark is not obtainable in the districts around Cawnpore, and the railway freight does not permit of its profitable use in that city. The tanning industry of Northern India relies on the supply of babul bark in the same way as the Madras industry depended on the occurrence of avaram bark.

The bark of *Acacia arabica* is not of importance as a tanning material outside India, where its abundance makes it a cheap and readily procurable tan. It is not sufficiently rich in tannin or attractive in its properties to be considered for the world market.

OAK BARK AND OTHER OAK PRODUCTS

One of the oldest and best known of tanning materials, at least as far as the United Kingdom is concerned, is oak bark, which has been used in the preparation of leather for many centuries. This material is particularly suitable for sole and other heavy leathers, but it penetrates the hide so slowly that the tanning process is rather long. In consequence, oak bark has in many tanneries been replaced by other materials with quicker tanning pro-

perties, while on the Continent it has been blended with pine bark, and in the United States with hemlock and chestnut extract. Nevertheless, in spite of this defect, and of its being one of the most expensive tanning materials, it is the most suitable material for the best grades of heavy leather. The consumption in Great Britain and Ireland in 1928 of oak and larch bark together was 10,000 tons, which represents about 7 per cent. of the total consumption of tanning materials in these countries. The whole of the oak bark used in the United Kingdom is from home supplies and none is exported.

The British oaks comprise two species, viz. *Quercus pedunculata* Ehrh., which occurs chiefly in lowland districts, and *Q. sessiliflora* Salisb., which is commoner in hilly regions. The best time of year for collecting the bark is between the middle of April and the middle of June, and it should be stripped as soon as possible after the trees have been cut down. In cases where the trees have been felled for some time before they are peeled, steam is occasionally used to assist in the stripping. The stripped bark is piled in stacks and allowed to dry, care being taken to prevent damage by rain and overheating. English bark is sometimes sold in "long rind" and sometimes "hatched" or chopped into pieces 4 in. long. Belgian and Dutch bark is usually hatched.

The best qualities of English oak bark are obtained from Sussex and Hampshire and contain from 12 to 14 per cent. of tannin. The average content of European oak bark is from 8 to 13 per cent., a good sample containing not less than 10 per cent.

Young coppice bark is richest in tannin and gives more satisfactory results than older bark. The coppice bark is obtained from plantation oaks less than 20 years old. Bark from older trees is less rich in tannin on account of the large amount of "ross" which covers the outer surface.

Oak bark is generally used as such in tanneries and is not often made into extract, although parcels of the extract are occasionally offered on the market. The bark of the American chestnut oak, *Q. Prinus* L., is used in the Alleghanies for this purpose and is stated to furnish the best oak bark extract manufactured.

The genus *Quercus* comprises numerous species, which are distributed widely over the northern hemisphere and are found also in Java and the mountains of Mexico and South America. Not every species, however, yields bark sufficiently rich in tannin for leather production.

Tannin is found not only in the bark of oak trees, but occurs also in other parts of the tree, such as the leaves, acorns and wood. The leaves of some species contain over 10 per cent. of tannin, but are rarely, if ever, employed commercially.

The cups of the acorns from one species at least, viz. *Q. Aegilops* L., are a valuable tanning material and are known in commerce as valonia; they contain on an average 31 per cent. of tannin. The valonia consumed in the United Kingdom is almost, if not entirely, imported from Asia Minor and Greece. An article dealing with the production and uses of valonia was published in the **BULLETIN OF THE IMPERIAL INSTITUTE (1912, 10, 645).**

Oak wood contains from about 5 to 13 per cent. of tannin, but rarely more than 9 per cent. The percentage of tannin reaches its maximum when the tree is about 45 years old. The lower portions of the trunk are richer than other parts, while the main root also contains a considerable amount of tannin. Oak wood is used in large quantities for the preparation of a tannin extract, particularly in Jugo-Slavia, and also in Russia, France, Spain and North America. For the purpose of extract manufacture, the heart-wood is considered to be best. Though other parts of the tree may contain more tannin, these also yield a relatively larger proportion of non-tannins. In Jugo-Slavia, the material employed for extract-making is the waste-wood from the furniture factories, supplemented by the larger branches. The species of oak most abundant in that country is *Q. pedunculata*. Oak wood extract is usually sold on a basis of a guaranteed tannin content. The Slavonian product on an average contains from 26 to 28 per cent. of tannin, while the Russian sometimes has over 30 per cent. Oak wood extract has weight-giving properties and yields a rather darker-coloured leather than does oak bark, even after the extract has been decolourised. It is employed

almost exclusively in the preparation of heavy leather and is best used towards the end of the process of tanning. Oak wood extract is stated to be rather rich in glucose and therefore ferments easily. The addition of 0·3 per cent. of sodium fluoride prevents this fermentation. When carefully made and decolourised the extract is excellent for pit-tanning, owing to its swelling action, but if it is desired to employ it in drum-tannage it should be blended with an equal weight of chestnut extract. Oak wood extract appears on the German market in three different strengths, viz. :

	Water. Per cent	Tannin Per cent	Non-tannins. Per cent
Liquid	55-67	22-30	—
Concentrated	36-40	41-45	15-18
Solid	12-23	54-63	15-28

With the exception of Great Britain and Ireland, the only countries in the British Empire which offer possibilities for the commercial exploitation of oak bark and oak wood are India and Burma.

India.—In this country, particularly in the region of the Himalayas, there exist large numbers of oak trees of various species, but not all of them contain sufficient tannin in the bark or wood to warrant their exploitation on a commercial scale. The barks of several species of Indian oaks compare very favourably with European bark. The extent to which this bark is used in India is practically negligible as other materials, richer in tannin, are available at a lower price. Many of the Indian oaks have been investigated with a view to their commercial utilisation. The commonest species occurring in India is *Q. incana* Roxb., in the bark of which as much as 23·4 per cent. of tannin has been found, although other samples have not shown nearly so high a percentage. The most promising variety is stated to be *Q. fenestrata* Roxb., containing 15·9 per cent. of tannin in the mature bark. This material has the advantage of giving a lighter-coloured leather than the other varieties tested. Other Indian barks which have been examined are those of *Q. dilatata* Lindl., 6·8-7·9 per cent. of tannin; *Q. semecarpifolia* Sm., 8·6-11·6 per cent.; *Q. pachyphylla* Kurz, 12·2 per cent.;

Q. lineata Blume, 9.7 per cent.; *Q. lamellosa* Sm., 0 per cent.

Large supplies of oak bark and wood are available in India and it has been suggested that some of the above-named species might be used for the manufacture of extract. As a rule, however, these oak trees grow at high elevations and the cost of transporting the bark from the forests to the central factory below would render it impossible to create a profitable industry.

Burma.—In Burma, as well as in India, there exists a large number of oak trees of various species, many of which have been examined to determine their value as a source of a tanning material. The results have shown that many species are of little or no value. In general the wood is more promising than the bark. It is interesting to note that in the case of some species the wood contains more tannin when collected in the winter than in the summer. Those mentioned in the following list¹ might be used for the manufacture of extract, but, as is the case in India, it is doubtful whether their utilisation for this purpose would be profitable. Small-scale tannages have been carried out on some of these materials, and the leathers produced, together with other results of the investigation, are described in *Indian Forest Records* (1924, vol. x, pt. xi).

					Tannin. Per cent.
<i>Q. Griffithii</i> Hook.	bole bark	.	.	.	9.3-10.4
	heart-wood	.	.	.	5.8-7.3
<i>Q. Kingiana</i> Craib	twig bark	.	.	.	19.5
	bole bark	.	.	.	19.4
<i>Q. serrata</i> Thunb.	twig bark	.	.	.	10.0
	outer bole bark	.	.	.	8.7
<i>Q. Brandisiana</i> Kurz	twig bark	.	.	.	18.9
	bole bark	.	.	.	32.8
	outer bole bark	.	.	.	17.5
	wood	.	.	.	8.5
<i>Q. polystachya</i> Wall.	twig bark	.	.	.	10.6
	outer bole bark	.	.	.	14.1
	average wood (winter)	.	.	.	8.5
<i>Q. Lindleyana</i> Wall.	average wood (winter)	.	.	.	9.5
	heart-wood	.	.	.	11.7
<i>Q. dealbata</i> Hook. fil. et Thoms. (open-topped acorn variety)	twig bark	.	.	.	8.9
	bole bark	.	.	.	10.6-13.2
	bole wood	.	.	.	10.9-12.2

¹ The botanical names in the list have been revised in accordance with information published in *Burma Forest Bulletin No. 19, Botanical Series, No. 1, 1928.*

Of these oaks *Q. dealbata* (open-topped acorn variety), *Q. polystachya* and *Q. Lindleyana* have been recommended as most suitable for re-afforestation purposes.

Although, as shown above, there are large quantities of oaks occurring in both India and Burma, there does not appear to be any immediate prospect of these resources being utilised to augment the existing supplies of tanning materials.

New Guinea.—Oaks have a wide range in the foot-hill and lower mid-mountain forests all round New Guinea proper. The three varieties most commonly occurring are *Quercus Junghuhni* Miq., *Q. spicata* Smith var. *depressa* King and *Q. lamponga* Miq. Their barks contain 16.3, 17.0 and 18.0 per cent. of tannin respectively. The first-named gave a very dark reddish-coloured leather, the second a fair yellowish colour and the third a bad colour. All three barks compare favourably with oak bark from European sources so far as percentage of tannin is concerned. The practicability of establishing extract works to treat the New Guinea bark is stated to be worth serious consideration. The export of the bark is not recommended.

LARCH BARK

Larch bark is one of the less commonly used tanning materials in the United Kingdom. It is derived from the tree, *Larix europaea* D.C., which grows in various countries of Europe and is fairly widely distributed. The bark contains from 9 to 10 per cent. of tannin and is suitable for the preparation of light leather. In Scotland it finds employment in the tanning of basils. Owing to the presence of sugars in the bark, a fair amount of acid is produced in the liquors.

The quantity of this material consumed in the tanneries of Great Britain and Ireland is not separately shown in the tables on pp. 4 and 5, but is included with oak bark. The total for these two materials was 10,000 tons in 1928. The whole of the larch bark is of home production, none being either imported or exported. Large quantities of larch bark are used in Russia, Hungary and Austria.

There does not appear to be much likelihood of the use of this material extending, but the bark can be profitably employed in places where the tree grows naturally. In Canada three species of larch occur, namely, *L. americana* Michx. (tamarack), *L. occidentalis* Nutt. (Western larch) and *L. Lyallii* Parl. (Alpine larch). In India *L. Griffithii* Hook. f. is found in the Eastern Himalayas, in Eastern Nepal, Sikkim and Bhutan at an altitude of from 8,000 to 12,000 ft. A sample of bark of the western larch grown in Oregon, U.S.A., was found to contain 10·6 per cent. of tannin, and it was suggested that the material might be utilised on a commercial scale for the preparation of extract.

WOODS

CHESTNUT

In 1928 the two chief vegetable tanning materials consumed in the United Kingdom were quebracho extract and myrobalans, and next in importance, and of almost equal value in respect of tannin units, were wattle (bark and extract) and chestnut extract. About 28,000 tons of chestnut extract were absorbed by the tanning industry in that year, the greater part coming from France, and the remainder from Italy and the United States of America.

The true or Spanish Chestnut (*Castanea sativa* Mill. = *C. vesca* Gaertn.) grows throughout the greater part of temperate Europe and also in the United States of America as far north as latitude 44°. In Europe it is most prolific in Italy, France, Spain, Switzerland, Jugo-Slavia and Corsica, while in America it abounds in Virginia, Western North Carolina, North Georgia and Eastern Tennessee. Allied species also grow in large numbers in India and Burma.

Chestnut extract of commerce is almost, if not entirely, made from the wood of the chestnut, the bark not being rich enough to allow it to be profitably employed for this purpose. As already indicated, the chief manufacturing countries are France, Italy and the United States. The air-dried wood contains from 8 to 13 per cent. of tannin on the average, although as much as 20·5 per cent. of tannin

has been reported for a sample from Corsica. As a rule, chestnut trees grown in northern regions contain less tannin in the wood than do trees grown in southern districts, the usual content being 7 to 8 per cent. for northern and 10 to 11 per cent. for southern wood. The heart-wood is the richest part of the tree, but the sap-wood is also used for extract manufacture. Chestnut extract tans hides and skins rapidly, giving a firm leather, and is used largely in the United Kingdom in conjunction with valonia, myrobalans and other materials for the preparation of sole-leather. Chestnut extract, when used alone, gives a leather of a more reddish colour than that produced by valonia.

Several concentrations of extract are on the market, and their composition is indicated below :

		Moisture. Per cent.	Tannin. Per cent	Non-tannin Per cent	Insoluble. Per cent.
Liquid extract		58-64	29-32	5-7	0·5-1·5
" "		54-59	32-37	5·9-5	0·5-1·5
Solid "		40-47	40-49	7·5-10	0·5-2·0
		9-25	56-76	5·5-9·5	0·5-4·0

As regards the chestnut extract imported into Great Britain and Ireland, the bulk is in liquid form ; the American product contains 29 per cent. of tannin and the French and Italian 27 per cent.

In the United States of America, owing to a widespread destruction of chestnut trees by blight, an investigation was undertaken to determine the possibility of utilising the stump wood, root wood and root bark. The root bark was found to contain over 30 per cent. of tannin and the root wood over 17 per cent.

Of the overseas countries of the British Empire, India and Burma are the only two where allied species of the chestnut grow in sufficient abundance to warrant their commercial exploitation.

India.—The chestnuts of India belong to the related genus *Castanopsis*. The species which have been investigated as to their possible utilisation as sources of tanning materials are *Castanopsis hystrix* A. DC., *C. tribuloides* A. DC. and *C. indica* A. DC. The last two are stated to

grow on relatively low ground ; for instance in the Tista valley they occur at about 500 feet. These species are plentiful and one of them at least extends into the plains of Bengal. On examination *C. hystrix* was found to contain 11.6 per cent. of tannin in the twig-bark and 13 per cent. in mature stem bark ; *C. tribuloides* 13.6 per cent. and 6.9 per cent. respectively, and *C. indica* 11.8 per cent. in the mature bark. It is worthy of note that both the leaves and twig bark of *C. hystrix* contain the same amount of tannin. So far the investigation has been of a preliminary nature, but it has already shown that the mature bark of *C. hystrix* and the twig-bark of *C. tribuloides* are promising materials. It must be borne in mind in connection with the commercial exploitation of these materials that the cost of transporting them from the hills to the rail-head would be comparatively heavy and might be sufficiently great to prevent their utilisation being remunerative. The bark and wood of these trees are being further investigated as materials for the manufacture of chestnut extract.

Burma.—The chestnuts of Burma have given more promising results than the Indian chestnuts. The two most prolific species found in Burma are *C. tribuloides* and *C. argyrophylla* Kurz, which grow abundantly and are widely distributed throughout the country. Of these the latter, which is not so plentiful as the former, furnishes bark which produces leather of a better colour than can be obtained with any other Burmese tanning bark. It is therefore recommended that this bark should be used for direct tannage for the production of sole and other heavy leathers. Samples of bole bark of this species have been found to contain as much as 18.2 per cent. of tannin. The tannin content of the bark of *C. tribuloides* has been found to vary according to the locality in which the tree is growing. Bark from Namyas contains 19 per cent. of tannin while that from Maymyo has only 13 per cent. Two varieties of the tree occur at the latter place and have been identified as *C. tribuloides* A. DC., var. *ferox* King and var. *echidnocarpa* King. The former is the more common variety. The wood of both *C. argyrophylla*

and *C. tribuloides* (Maymyo variety) is comparatively rich in tannin, containing 12 and 16 per cent. respectively. As was noticed in the case of Burmese oaks, wood collected in the winter months is richer in tannin than that gathered in the summer.

Numerous experiments with Burmese chestnuts have been carried out at the Forest Research Station, Dehra Dun, and have shown that these trees give an extract richer in tannin than any of the European trees, while small-scale tanning trials have indicated the suitability of the bark and wood for the production of a good leather.

These investigations therefore demonstrate that the chestnuts of Burma could be used for the manufacture of extract, but whether the production of such extract in Burma is a commercial possibility has not yet been proved. If a product of good quality could be made in that country at a cost which would allow a profit to the producer and at the same time enable it to compete successfully with extract from other countries, a ready market would be found in the United Kingdom.

CUTCH

"Cutch" is a name applied to solid tanning extracts, derived from several sources. Formerly it was used solely to designate the solid product obtained by concentrating an aqueous extract of the heart-wood of *Acacia Catechu* Willd., but at the present time, when cutch is mentioned in the United Kingdom, the solid tanning extract prepared from mangrove bark is usually meant. In the following account, however, the word "cutch" is used in its original sense.

Cutch is obtained from *Acacia Catechu* Willd., a tree, some 30 to 40 ft. in height, which grows in India and Burma. This tree also occurs in tropical East Africa, where, however, it is not used for the manufacture of cutch. Cutch may also be prepared from *A. Suma* Kurz and *A. Sundra* DC., which occur in South India.

For its preparation, the wood, preferably the heart-wood, of the tree is cut into small chips and boiled in water for about 12 hours in earthen pots. By the end of this time the water has been reduced in volume to about

one-half. The liquor is then poured into a large cauldron and further boiled and stirred until it attains the consistency of syrup. It is now transferred to wooden frames lined with leaves and allowed to cool, when it hardens to a brick-like mass. In some districts, the liquid after being boiled for several hours is poured over a further supply of untreated chips and again boiled. The yield of cutch is from 3 to 10 per cent. of the weight of the wood. In the preparation of cutch by native methods, the chips used are so large that a considerable quantity of tannin remains in them after boiling. Experiments have been carried out with a view to demonstrating the possibility of increasing the yield of cutch. The results showed that the wood should be treated in the form of shavings, thereby trebling the yield ; the quantity of water required is not more than ten times the weight of the wood and the shavings only need to be boiled for 30 minutes.

Two kinds of cutch are made in India, viz. "dark catechu" or "cutch," and "pale catechu" or "katha." The latter is used by the natives for chewing.

A. Catechu trees vary in value as a source of cutch, and in some cases are useless, e.g. certain trees growing in Bikaner have been shown to be too poor in tannin for the purpose. The value of the trees also increases with the size.

Cutch of commerce is of a rusty brown or dull orange colour, of brittle texture and shiny fracture. It contains, on the average, 60 per cent. of tannin, together with a crystalline substance, catechin. The latter substance crystallises out from strong extracts on cooling and in many cases is removed in the preparation of cutch. As a tanning material cutch is not satisfactory as the leather produced is harsh and apt to give a yellow stain. It is used largely in tanning fishing nets and to a small extent as an astringent in medicine. Formerly large quantities were employed in dyeing, but it has now been replaced to a great extent by aniline dyes.

Burma is the chief country producing cutch. Twenty-five years ago it had a large trade in the material, but of recent years this trade has declined owing to cutch having been replaced in industry by cheaper materials, viz. man-

grove extract and aniline dyes. There does not appear to be any great possibility of the trade expanding in the future owing to the restricted market for the product.

In Eastern Bengal and Assam there are numbers of *A. Catechu* trees, and should a demand arise for increased supplies of cutch, it would probably be possible to organise a remunerative industry in these Provinces.

Experiments were undertaken a few years ago in Madras which showed that *A. Sundra* yielded cutch of good quality. In consequence a firm sought concessions to exploit the trees, but their proposal was abandoned as the Forestry Department had not sufficient trees under their control to enable them to grant concessions over large enough areas to make the enterprise remunerative.

In the trade returns for India cutch and gambier are included together. The quantities of these materials produced in British India and exported during the years 1923-28 are shown in the table on p. 53, together with the chief countries to which they are shipped. Of the total exports Burma supplies by far the greatest quantity, Bengal coming next with considerably smaller amounts. It may be pointed out that these figures may be taken as actually applying to cutch only, as very little, if any, gambier is prepared in either India or Burma.

LEAVES

GAMBIER

Gambier is a solid extract prepared from the leafy twigs of *Uncaria Gambier* Roxb. (N.O. *Rubiaceæ*), a climbing shrub which is cultivated in the East Indies and Malaya. For its preparation leaves from the shrub (or preferably prunings) are warmed with a small quantity of water, the mixture being constantly stirred for two hours. The leafy material is then removed and the boiling continued. When the liquor has been concentrated to the desired consistency it is transferred to wooden frames where it is allowed to cool for an hour, being stirred the while. The liquor thickens on cooling and becomes yellow in colour and semi-solid. The mass is then cut into cubes, with sides about 1 to 2 in. long, and dried in the shade.

Exports of Cutch and Gambier from British India

GAMBIER

53

	Quantity (mts.)					Value (rupees).				
	1923-24	1924-25	1925-26	1926-27	1927-28	1923-24	1924-25	1925-26	1926-27	1927-28
United Kingdom.	26,777	30,562	37,654	24,982	28,115	5,37,260	6,43,193	9,89,942	5,24,939	4,98,902
Germany	2,155	2,433	2,147	2,082	3,146	40,477	47,934	51,634	50,103	58,299
Netherlands	4,490	5,438	4,800	3,647	4,868	93,854	1,35,921	1,34,549	81,618	92,116
Belgium	300	450	1,220	264	250	5,155	9,251	31,574	5,485	4,485
France	6,106	7,271	5,827	3,650	3,694	1,15,660	1,51,802	1,43,215	79,719	71,941
Italy	550	2,053	1,375	875	835	11,813	43,947	32,986	18,403	16,406
Japan	301	1,521	1,104	550	900	5,247	22,667	31,559	13,256	15,798
United States of America	5,001	2,995	3,655	2,673	2,796	1,95,321	60,923	89,249	51,115	51,401
Other Countries.	1,178	842	2,045	1,351	1,423	37,899	29,290	77,944	40,321	40,690
Total	46,858	53,565	59,827	40,074	46,027	9,52,686	11,40,148	15,82,652	8,64,959	8,50,308

The drying may also be effected in the sun or by artificial heat. The final product is known as "cube" gambier, and contains from 36 to 44 per cent. of tannin. It appears to be the practice in some quarters to add rice bran during the final stages of the concentration of the liquor, but this custom is to be deprecated.

U. Gambier is easily cultivated and after two years prunings may be made every six months. More frequent harvesting of the leafy material has a detrimental effect upon the life of the shrub. The material should be worked up as soon as possible after collection as the tannin content decreases on storage. Beside being prepared as "cube" gambier, the material is also marketed in the form of bales. For this grade the semi-solid mass of extract is not cut up into cubes and further dried, but is merely sold as it is, wrapped in grass mats and covered with sacking. The bales weigh about 60 lb. each. Gambier in bales contains more moisture than "cube" gambier, and is sold at a cheaper price, the respective percentages of tannin being 20 to 26 and 42 to 44. The custom in many modern factories is to market the product in block-form, packed in wooden boxes.

The manufacture of gambier is, particularly in the Dutch East Indies, carried on mainly by Chinese, and their product is often found to be adulterated. There are, however, some factories under European control and their products are generally more reliable. Gambier is also marketed in the form of a yellowish-brown paste, in the preparation of which modern equipment is employed. The product contains about 38 per cent. of tannin and a relatively small amount of insoluble matter. It is sold with a guaranteed maximum moisture content of 31 per cent.

There is a large world demand for gambier as a tanning material, and also a considerable demand for it in the East for use as a masticatory. The result is that only part of the amount produced is exported. In Java, for instance, large quantities are manufactured, but further quantities have to be imported from the neighbouring islands to meet the local demand for chewing purposes.

It is estimated that the world demand for gambier is

about 25,000 tons per annum. In the United Kingdom in 1927, 2,097 tons of gambier were imported. About two-thirds of this quantity came from the Straits Settlements, mostly in the form of bale gambier. The remaining one-third came almost entirely from the Dutch East Indies. Of the total imports in 1927, 207 tons were re-exported, chiefly to Belgium.

Gambier was formerly used in the United Kingdom for tanning calf skin and kips, but its use for this purpose gradually declined. When employed alone, the material gives a rather spongy leather, but when used in conjunction with other materials, such as wattle and myrobalans, it is suitable for both heavy and light leather.

British Malaya.—Of the countries of the Empire, British Malaya is the only one which exports any appreciable amount of gambier. The total exports are given in the tables on pp. 57 and 59. A large proportion of these exports represents gambier imported from Sumatra and other parts of the Netherlands East Indies, as will be seen from the following table. It cannot be definitely stated that these quantities were all re-exported, as no information is available as to the amount consumed locally.

Imports of Gambier into British Malaya

	Bale Gambier.		Cube Gambier.	
	Total.	From Nether-lands East Indies.	Total	From Nether-lands East Indies.
1923	Cwts. 11,795	Cwts. 10,883	Cwts. 36,220	Cwts. 36,036
1924	5,372	4,103	51,698	51,571
1925	7,860	7,320	44,120	43,920
1926	12,920	12,840	31,580	31,420
1927	11,400	11,400	26,260	26,120

On the Malay Peninsula there are estimated to be 5,000 acres under cultivation with gambier in Trengganu, 1,000 acres in Johore and 2,300 acres in the Federated Malay States, mostly in Negri Sembilan. The cultivation has been recently extended owing to the high price now ruling for the product. The growing of gambier with

pepper is recommended as the extracted leaves make a good manure for the latter. In many cases gambier is being cultivated as a catch crop on rubber and oil-palm estates. At one time there was an opinion prevalent that gambier was exhaustive to the soil and therefore could not be recommended as a catch crop, but further investigation has led to the conclusion that the economic cultivation of gambier does not ultimately diminish the fertility of the soil to a greater extent than most other catch crops.

Investigations were carried out with material grown on the Government Experimental Plantation, Serdang, to determine the factors which influence the quality of the product. These showed that for gambier of the best quality the cuttings should be used as fresh as possible. Extraction at temperatures above 80° C. causes decomposition of the tannin to take place. Concentration of the liquor at a low temperature gives a product of high quality and of good colour. The experiments also demonstrated that with simple apparatus as used by native cultivators, bale gambier of a uniform light mustard-yellow colour and almost completely soluble in water can be readily obtained.

British West Indies.—Attempts have been made to grow the gambier plant in the British West Indies, but although the climatic conditions in Trinidad, Dominica and British Guiana are favourable to its growth, the results have shown that the plant is not adapted for cultivation in the West Indies on a commercial scale.

British North Borneo.—*Uncaria Gambier* also grows in British North Borneo. Samples of the product prepared in this part of the Island some years ago were pronounced to be equal in quality to Singapore gambier. At the present time gambier is still being manufactured there, but the quantity exported is negligible.

Ceylon.—Trials were made years ago in Ceylon to determine whether gambier plants would grow in the Island. Plants were reared at Henaratgoda and grew rapidly, showing that *U. Gambier* could be propagated, without much difficulty in this Colony.

GAMBIER

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Imports of Gambier into the United Kingdom

Countries whence consigned	Quantity (cwt.)						Value (£)				
	1923	1924	1925	1926	1927	(a)	1923	1924	1925	1926.	1927
Netherlands	—	194	226	114	—	—	537	810	125	—	(a)
Dutch Possessions in the Indian Seas	4,184	10,989	12,438	11,843	13,738	8,378	29,249	39,183	30,694	31,722	—
Turkey, Asiatic China, exclusive of Hong Kong, Macao and leased territories	—	—	283	—	—	—	—	—	—	—	—
Other Foreign Countries	4,020	500	—	100	245	7,854	1,061	—	225	360	383
Straits Settlements and Dependencies (including Labuan)	1,912	515	583	460	148	3,961	1,759	1,781	360	360	281
Other British Countries	43,798	24,435	27,484	21,664	26,839	92,948	67,015	88,082	46,074	48,288	—
Total from Foreign Countries	200	3,019	1,928	539	98	370	9,512	3,169	1,340	2,018	—
Total from British Countries	43,998	27,454	33,530	12,517	14,126	20,193	32,606	43,312	31,404	32,386	—
Grand Total	54,114	39,652	42,042	34,660	41,946	113,511	109,133	134,553	78,818	82,692	—

(a) Not separately recorded

Exports (including Re-exports) of Bale Gambier from British Malaya

Destination.	Quantity (cwt.)						Value (dollars)				
	1923.	1924.	1925.	1926	1927.	1923	1924.	1925	1926.	1927.	—
United Kingdom	9,137	9,463	7,1440	11,420	12,020	123,473	188,312	142,759	120,905	91,041	—
Belgium	4,539	6,127	10,720	6,040	5,600	55,678	121,492	184,917	68,839	46,951	—
France	2,616	3,991	6,420	4,000	900	35,786	84,542	112,338	44,205	6,879	—
Germany	1,007	3,311	1,460	1,200	2,340	12,016	72,060	30,158	11,022	18,991	—
United States of America	714	18,925	8,920	9,600	6,700	10,067	401,805	162,876	109,249	56,135	—
Other Countries	323	1,640	2,240	1,220	880	3,525	32,929	40,462	15,561	7,825	—
Total	18,336	43,457	37,200	33,540	28,440	240,545	901,140	673,550	367,781	226,922	—

Conclusions.—The trade in gambier, while not capable of enormous extension, is of considerable value. The next few years will probably see an improvement in the quality of the product, and the price will doubtless be lowered on account of the increased planting that has recently taken place.

The cultivation as a catch crop on rubber or oil-palm estates is meeting with considerable success and a profitable opening is offered in this direction.

SUMACH

Sumach is derived from *Rhus Coriaria* L., a native of the European countries bordering the Mediterranean, the commercial supply being obtained almost entirely from plants cultivated in Sicily. Within the British Empire the only country producing sumach is Cyprus, but until recently its relation to the world supply was insignificant. In view of the great improvement effected in the quality of the Cyprus product during the last few years, that country now promises to become of importance as a source of sumach, though the amount produced must for long remain relatively small as compared with the Italian output. The Sicilian product is stated to be produced from two distinct varieties of *R. Coriaria*, one of which, named "sommacco mascolino," is grown in the provinces of Girgenti and Trapani and contains from 30 to 32 per cent. of tannin, whilst the other, termed "sommacco femminello," obtained from the east of the Island, contains from 22 to 24 per cent. The product is exported chiefly in the form of a fine powder consisting of the ground leaves, leaf stalks, and thinner stems, and is sold as containing 25 or 28 per cent. of tannin. Most of the sumach collected in the Island is forwarded to Palermo, where it is ground in stone mills of the edge-runner type; the process involves a system of sieving and the re-grinding of the coarser particles. During its preparation the material is submitted to the important process of purification termed "ventilation," which consists of blowing the material by means of a fan along the factory floor, so that the heavier mineral impurities and particles of metallic iron (derived from the grinding machinery) remain behind. Ground

Exports (including Re-exports) of Cube Gambier from British Malaya

Destination.	Quantity (cwt.).					Value (dollars).				
	1923	1924	1925	1926	1927	1923	1924	1925	1926	1927.
United Kingdom . . .	3,467	410	1,900	840	2,000	58,927	14,309	50,060	12,675	22,668
British India and Burma . . .	38,481	37,690	39,400	35,880	34,340	772,345	983,194	798,911	504,494	387,391
Hong Kong . . .	1,486	2,666	3,780	3,900	3,900	25,115	77,364	90,883	106,110	72,636
Belgium . . .	1,970	—	160	—	—	27,188	—	4,099	—	—
France . . .	6,335	—	20	—	200	91,729	—	500	—	2,791
Germany . . .	4,882	7,375	5,480	3,360	5,660	83,219	235,120	134,755	47,457	66,823
Italy . . .	2,670	300	740	500	700	39,418	9,792	18,952	7,623	8,984
French Indo-China . . .	4,701	4,996	6,260	6,820	6,940	110,158	181,152	168,757	123,319	77,241
Japan . . .	636	3,360	4,560	4,620	3,000	15,906	113,815	149,250	105,425	48,068
Java . . .	9,857	15,831	4,820	540	20	209,180	597,251	161,972	14,100	500
Philippines and Sulu Archipelago . . .	1,463	1,451	1,780	1,340	1,480	33,769	46,122	50,992	28,631	21,916
Siam and Siamese States . . .	1,834	1,624	1,400	1,360	1,760	49,654	56,085	42,612	36,847	48,148
United States of America . . .	28,072	5,188	4,100	3,640	9,700	423,946	191,817	119,608	68,532	117,472
Other Countries . . .	1,855	1,593	3,820	3,440	2,780	39,863	45,922	80,363	77,970	40,790
Total . . .	107,709	82,484	77,220	66,240	71,580	1,980,427	2,551,943	1,870,904	1,133,203	915,428

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sumach is shipped in bags of 75 kilos. The unground leaves are also exported, compressed in bales weighing usually from 250 to 300 kilos., and are largely employed for extract making.

Commercial sumach is frequently adulterated with the ground leaves of many other plants containing tannin, including other species of *Rhus*. The chief adulterant is *Pistacia Lentiscus* L., an evergreen tree which grows abundantly in Cyprus. Large quantities of the leaves of this tree, which contain 12 to 19 per cent. of tannin, are said to be annually exported to Palermo for this purpose.

Sumach finds extensive employment in the light leather industry, and belongs to the pyrogallol class of tannins. It furnishes the best known tannage for white or light-coloured soft and supple leathers, and is therefore very largely employed in the tanning of roans, skivers, moroccos, glove, bookbinding and upholstery leathers. The tannin of sumach is of a non-astringent character, consisting mainly of gallo-tannic acid ; the leather it produces does not darken on exposure to light, and has been shown to be more resistant to ordinary gas fumes, and less liable to general decay than those furnished by any of the more modern tannages. Sumach is found very useful for brightening leathers of darker tannages, such as wattle and gambier, and as it affords white or nearly white leather, such leather is especially suitable for dyeing.

The world demand for sumach has fallen off since the war, the best markets being the United Kingdom, the United States, France and Germany. The present consumption in this country is about two-thirds of what it was before the war, the average annual amount of the imports retained for consumption during the five years ending 1913 being 163,551 cwts., as compared with 103,127 cwts., for the five years ending 1928. From the table on p. 62, showing in detail the imports of sumach into the United Kingdom for the five years 1923-27, it will be seen that British tanners are dependent for their supplies on foreign countries, principally Italy, the amount produced within the British Empire being at present of little importance. A phenomenal rise in the price of sumach took place during the years 1924-25, but the

price has since fallen, as will be seen from the graph given on p. 97.

Cyprus.—The Island of Cyprus affords the only commercial source of sumach within the British Empire. *Rhus Coriaria* is one of the principal indigenous native tanning materials of Cyprus, being found throughout the greater part of the Island, and flourishing especially among the vineyards on the slopes of the southern range of hills. A sample of dried leaves of Cyprus sumach examined some years ago at the Imperial Institute was found to contain 27 per cent. of tannin, the material thus comparing favourably with the Sicilian product (see BULLETIN OF THE IMPERIAL INSTITUTE, 1912, 10, 45). For many years Cyprus has exported sumach to Egypt and Syria. Formerly the whole leaves only were exported, but since 1905, in view of the demand for the powdered material, stone mills have been erected in the Island for grinding the leaves. Small consignments of the ground leaves have from time to time reached this country, but as the process of "ventilation" was seldom properly conducted, the product was almost invariably contaminated with impurities, including particles of metallic iron, and was thus very inferior to Palermo sumach, and quite unsuitable for the United Kingdom market. Samples of some of this sumach ground in Cyprus, which were examined at the Imperial Institute, showed a tannin content of from 19 to 23 per cent., but furnished 9 to 14 per cent. of ash, and contained from 0.3 to 0.5 per cent. of metallic iron (see BULLETIN OF THE IMPERIAL INSTITUTE, 1919, 17, 534). It was made clear that this imperfectly ventilated material could never hope to find employment in the tanneries of this country, but that on the introduction of efficient ventilating machinery, Cyprus would be able to produce sumach equal in quality to the Sicilian product, and that a considerable export might then be established to the United Kingdom. Since 1923 a factory on modern lines has been erected in the Island and now produces sumach that is considered fully equal to the Sicilian product. The output finds a ready market in this country. The table given on p. 63 is the official record of exports

Total Imports of Sumach into the United Kingdom, 1923-27

Country whence consigned	1923			1924			1925			1926			1927.		
	Cmts.	f	Cmts.	f	Cmts.	f	Cmts.	f	Cmts.	f	Cmts.	f	Cmts.	f	Cmts.
Cyprus	—	—	77,620	60,909	95,400	136,522	78,046	107,005	8,184	9,007	5,755	4,925	—	—	—
Italy	—	—	17,911	16,326	18,060	20,413	9,446	13,387	87,701	80,784	97,484	74,852	—	—	—
Spain	—	—	—	1,600	—	—	6,103	3,490	3,086	4,283	3,000	1,745	1,442	—	—
Tunis	—	—	3,937	1,248	703	318	434	1,491	2,301	527	332	526	—	—	378
Other Countries	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	100,716	79,538	113,778	157,369	95,256	126,513	101,498	95,596	105,510	81,597	—	—	—

Re-exports of Sumach

Countries to which consigned.	1923			1924			1925			1926			1927.		
	Cavls	f	Cavls	Cavls	f	Cavls	f	Cavls	f	Cavls	f	Cavls	f	Cavls	f
British Empire	.	.	479	417	906	1,346	804	1,221	868	978	413	362			
Foreign Countries	.	.	2,661	2,040	170	196	522	563	1,269	1,294	363	339			
Total	.	.	3,140	2,457	1,976	1,542	1,326	1,784	2,137	2,272	776	701			

Exports of *Sumach* from Cyprus, 1923-27

SUMACH

	1923.	1924	1925.	1926.	1927
	Cents.	£	Cents.	£	Cents.
United Kingdom	—	—	—	—	—
Palestine	10	4	—	—	—
Egypt	2,284	983	1,255	414	1,075
Syria	7,695	2,870	5,396	1,992	1,519
Germany	—	—	1,983	661	6,135
France	—	—	—	—	329
Belgium	—	—	—	—	—
Italy	112	41	406	436	1,159
Greece	—	—	383	137	192
Roumania	—	—	257	107	739
Castellorizo	—	—	—	90	35
Dodekanesia	190	69	120	48	39
Turkey	89	34	142	48	120
United States	—	—	727	274	335
Total	10,380	4,001	10,759	4,152	12,062
					5,048
					20,845
					12,190
					13,831
					8,311

of sumach from Cyprus during the five years 1923-27. It will be seen that Egypt and Syria, formerly the principal importers, now receive a comparatively small proportion of the total exports, and that the United Kingdom and Belgium are the largest consumers.

Australia.—*Rhus Coriaria* was introduced many years ago into Australia, and is said to thrive well in the dry plains of the Wimmera district.

The leaves of several other species of *Rhus* are used for tanning under the name of sumach, but they usually contain an appreciably lower percentage of tannin, and furnish an inferior darker-coloured leather, and therefore have not attained the commercial importance of the Sicilian product. *R. Cotinus* L., a European species, known as Turkish or Venetian sumach, is also found in India, being indigenous to Western Himalaya and the Suliman Range. Throughout this area the leaves, bark and wood are used in dyeing and tanning. Reference is made in the BULLETIN OF THE IMPERIAL INSTITUTE (1916, 14, 482) to an investigation of this Indian sumach by Puran Singh who stated that the leaves, when collected in the autumn after the rains, contained from 18 to 22 per cent. of tannin, and in one case as much as 26 per cent. (31 per cent. expressed on the dry material). According to Watt the true sumach, *R. Coriaria*, is common in Afghanistan, and might easily be cultivated in India. *R. glabra* L., which is somewhat extensively cultivated in the United States, does not appear to be represented in the British Empire. The leaves of this species contain from about 21 to 28 per cent. of tannin, but furnish a darker-coloured leather than Sicilian sumach.

FRUITS

MYROBALANS

The astringent fruits, known as myrobalans, of several species of *Terminalia*—an extensive genus distributed over the tropics of the world—have long been employed for tanning purposes by the natives of India and are now

exported in large quantities. The most important commercial species is *T. Chebula* Retz., the chebulic or black myrobalan, which in Europe is the best known of the Indian tanning materials. The production and marketing of this product were fully dealt with in a *Report on the Trade in Indian Myrobalans*, furnished to the Secretary of State for India by the Imperial Institute Special Committee on Hides and Tanning Materials, and published in the series of Indian Trade Enquiry Reports (London: John Murray, 1922). *T. Chebula* occurs throughout India and Burma as a deciduous tree which varies in size according to the locality and conditions of growth. In forests it attains a height of from 40 to 50 ft., and affords a useful timber. The trees and their fruits are subject to so much variation that several different forms or varieties are recognised. The commercial supplies of myrobalans are largely derived from privately-owned forests, but are also obtained from forests belonging to the Indian Government or to Native States. Five different varieties are known on the English market, which are named after the districts where they are marketed :

- (1) "Bhimlies" from Bimlipatam in Madras ;
- (2) "Rajpores" from Bombay ;
- (3) "Jubbelpores" from Jabbalpur in the Central Provinces ;
- (4) "Vingorlas" from the Bombay forests ;
- (5) "Madras Coast."

There are usually two grades of each of these varieties.

Some uncertainty has existed as to the best time for gathering the fruits. Bhimlies and Jubbelpores, which are the most esteemed varieties, are generally collected in the green, unripe condition. Bombay fruits, on the other hand, are gathered when riper. The latter have smoother skins and larger wrinkles, and are often rather soft, waxy and spongy. As a rule they are not in so much favour with tanners, although they frequently contain a higher percentage of tannin. The examination at the Imperial Institute some years ago of samples of Bombay myrobalans in different stages of development showed that the riper fruits contained the most tannin. This has been confirmed in a more recent investigation in India on the best season

for collection. The fruits examined were obtained from Madras and the Central Provinces, and it was recommended that they should be gathered as soon as they were fully ripe, when they were the richest in tannin. The commercial value of myrobalans is, however, not governed altogether by the percentage of tannin they contain, but depends also on various other qualities which render some varieties more suitable than others for producing certain classes of leather. For instance Jubbelpores have been shown to be the most valuable for weight-producing. Moreover this variety and Vingorlas have been found to furnish the largest amount of "bloom." This is mostly formed during the early stages of tanning, whereas in the case of most of the other varieties the greater part of the "bloom" is deposited later.

The following table shows the percentage composition of samples of the chief commercial varieties of myrobalans examined at the Imperial Institute, together with the figures obtained by Parker and Blockey (*Journ. Soc. Chem. Indust.*, 1903, 22, 1182), for carefully selected average commercial samples. The results have been re-calculated to a uniform moisture content of 10 per cent.

—	Tannin		Extractive matter (non-tannin).		Soluble matter.		Ash
	Imperial Institute	Parker and Blockey	Imperial Institute	Parker and Blockey	Imperial Institute.	Parker and Blockey	Imperial Institute.
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Bhimlies—B ₁ .	32·5	39·3	16·4	16·5	41·1	34·2	2·6
B ₂ .	27·3	36·0	16·4	14·5	46·3	39·5	2·6
Jubbelpores—J ₁ .	34·6	37·3	15·0	14·7	40·4	38·0	3·1
J ₂ .	25·5	27·9	17·7	14·4	46·8	47·7	2·9
Rajpores—R ₁ .	35·6	36·2	14·0	12·4	40·4	41·4	2·4
R ₂ .	24·3	28·2	15·6	13·0	50·1	48·8	2·2
Vingorlas—V ₁ .	29·6	32·2	13·3	9·7	47·1	48·1	2·3
V ₂ .	24·3	—	15·1	—	50·6	—	2·3
Fair Coast Madras	—	35·5	—	15·7	—	38·8	—

The estimation of tannin at the Imperial Institute in a number of samples of myrobalans received from India some years ago furnished the following results :

—	Percentage of tannin expressed on whole fruits containing 10 per cent. of moisture.			
	Minimum.		Maximum.	
Bombay (43 samples)	25·1		42·3	
Madras (15 samples)	19·6		44·8	
Burma (7 samples)	7·7		31·0	

In view of the great variation in the amount of tannin in these samples, it seemed desirable to ascertain whether this was due to the variety of tree or to the locality in which the fruits were grown. An application for further samples was accordingly made, and about fifty samples were duly received during the years 1922 and 1924 from the Forest Botanist at Dehra Dun. The fruits were derived from various species of *Terminalia*, but mostly *T. Chebula*, and were obtained from different parts of the country. The results of this investigation were published in the BULLETIN OF THE IMPERIAL INSTITUTE (1924, 22, 123, 413), and are summarised in the following table :

Presidency or Province.	Species	Number of samples.	Percentage of tannin expressed on whole fruits containing 10 per cent of moisture.	
			Minimum.	Maximum.
Madras . . .	<i>T. Chebula</i> Retz.	21	25·6	49·0
Bombay . . .	" "	2	31·3	35·9
United Provinces . . .	" "	7	19·8	30·2
Punjab . . .	" "	3	25·7	36·1
Central Provinces . . .	" "	4	30·1	36·7
Madras . . .	<i>T. pallida</i> Brandis	4	19·0	38·3
Burma . . .	<i>T. tomentella</i> Kurz	3	14·1	19·2
Madras . . .	<i>T. travanicensis</i> W. & A.	1		31·5
Assam . . .	<i>T. citrina</i> Fleming	1		26·2

The results of this examination showed that the fruits of *T. Chebula* from different districts varied widely in appearance and in the quantity of tannin they contained. Fruits from the Salem Division of Madras, of which 12 samples were examined, contained the highest percentage of tannin, the average amount being about 42 per cent. This is considerably higher than the average tannin content of good commercial myrobalans, which is about 32 per cent. Fruits of the other species generally contained less tannin than those of *T. Chebula*. As only a few samples of these other species of fruits were included, further samples would have to be examined before definite conclusions could be drawn as to their relative values.

Two samples of fruits were forwarded which are not recorded in the above table. These were described as *T. Chebula* from Burma, but their appearance was quite distinct from all the samples of *T. Chebula* from India.

They were identical with the four samples of *T. tomentella* from Burma, and contained correspondingly low amounts of tannin, namely 12 and 17·3 per cent. respectively. According to the *Indian Forest Bulletin No. 32* (1916) the identification of the so-called *T. Chebula* of Burma with the *T. Chebula* of India is doubtful. Kurz has regarded the Burma myrobalans as *T. tomentella*, which, however, is classified by Hooker as a variety of *T. Chebula*. Seventeen samples of these myrobalans collected from various parts of Burma, and examined in India by Puran Singh, were also found to contain only about half as much tannin as the Indian fruits, and generally an excess of soluble non-tannins. The tannage of Burmese myrobalans resembles that of the Indian fruits, the leather being of similar quality but darker in colour.

Myrobalans are one of the most important tannin materials of the pyrogallol class. The tannin is not very astringent, and penetrates the hide very slowly. When used alone they yield a soft mellow and rather spongy leather which does not possess good wearing properties. They are therefore usually blended with the most astringent and quickly penetrating tannins, such as quebracho, wattle and mangrove, the red colour of which is thereby neutralised, and a brighter, more satisfactory colour is imparted to the leather. In India these fruits are largely employed in conjunction with babul (*Acacia arabica* Willd.), avaram (*Cassia auriculata* L.) and mangrove barks, and also as a "bleaching" agent at the end of the tannage of the East India kips of Madras and Bombay. One of the principal properties of myrobalans is their acid-forming power. They contain from about 3 to 5 per cent. of sugary matter, which is considerably more than is present in most tanning materials, and fermentation therefore readily takes place and satisfactory plumping is secured during the early stages of tanning. Myrobalans moreover contain a large proportion of ellagitannic acid, and are therefore one of the chief bloom-yielding tanning materials and are especially useful in the production of sole leather. They are not, however, considered a good weight-giving tan-stuff as the proportion of tannin combining with the hide substance is small when compared with other tanning materials.

Experiments conducted with Empire tanning materials during the war, when there was a shortage of foreign supplies, established the value of the mixed tannage of myrobalans and wattle bark. The astringent, readily penetrating wattle liquors are mellowed by the addition of myrobalans which, through natural fermentation, provide the necessary degree of acidity, and render the leather brighter in colour while diminishing its tendency to become red on exposure to light.

The following figures have been published (*Leather Trade Review*, 1925, 58, 627) showing the relative speeds of penetration, and also the gains in weight of the dry pelt afforded by some of the principal commercial tanning materials. It will be seen that, with the exception of Canaigre (*Rumex hymenosepalus* Torr.), myrobalans possess the slowest penetration powers and are the most inferior in weight-giving of all the materials enumerated.

	Speed of penetration of different tanning materials <i>Minutes.</i>					
Quebracho extract						2
" wood						3
Oak bark						6
" wood (not decolourised)						9
Hemlock extract						10
Wattle bark						11
Oak wood (decolourised)						12
Chestnut.						13
Valonia						17
Myrobalans						60
Canaigre						9½ hours

	Gain in weight of dry pelt with different tanning materials. <i>Per cent.</i>					
Oak bark						105·6
Valonia						103·4
Oak wood (not decolourised)						102·7
" " (decolourised)						100·7
Chestnut						99·6
Quebracho extract						99·1
" wood						98·4
Wattle bark						94·5
Canaigre						94·3
Hemlock extract						93·4
Myrobalans						75·6

In addition to their employment in the tanning industry, appreciable quantities of myrobalans are used as a

dye, and as a mordant in the dyeing of cotton, and also for the weighting of black silk and in the manufacture of ink.

The sun-dried fruits are generally picked over before being shipped in bags, which vary in weight according to the port of consignment. In Madras the bags weigh 164 lb. each, in Calcutta 56 lb., and in Bombay 140, 168 or 182 lb. As the stones of the myrobalans constitute from about 20 to 50 per cent. of the fruit, and contain only about 2 to 4 per cent. of tannin, their removal would furnish a product containing about 20 per cent. more tannin and would at the same time effect a considerable economy in freight. Consignments of stoneless crushed myrobalans when first exported to Europe (about 1911) appear to have been principally consumed by Continental tanners. During the war, owing to transport difficulties, increased quantities of crushed myrobalans were shipped and met with more extensive employment in this country. The crushed product, however, has been slow to find favour with British tanners, largely owing to the fact that the material in this form lends itself so readily to adulteration, and also to contamination with unsound fruits. Moreover, as already mentioned, preference is given by different tanners to certain varieties and grades of myrobalans, and without being able to handle the whole fruits they can never be certain of securing the grade they require. Crushed myrobalans are now quoted regularly on the English market at a price about one-third as much again as that of the whole fruits, the product containing about 45 per cent. of tannin.

The following tables show the exports of myrobalans (including the crushed fruits) from India for the five years ending the 31st March, 1928, and also the trade of the United Kingdom in this commodity for the years 1923-27. It will be seen that the United Kingdom during this period was the largest consumer, and that shipments to the United States rank next in importance. It is noteworthy that the amount taken by the latter country, which averaged about 280,000 cwts. up to 1926-27, was more than doubled in 1927-28, falling in that year only a little short of the quantity exported to the United Kingdom. The direct exports to Germany, which country during these five years was the third largest consumer, showed

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Exports of Myrobalans from India

	1923-24.	1924-25	1925-26.	1926-27	1927-28.
Total Exports quantity (cwt.)	1,324,751	1,339,359	1,042,557	1,377,633	1,927,487
Total Exports value (rupees)	7,262,422	7,935,561	7,372,222	8,154,302	12,203,697
	Cwts	Cwts.	Cwts	Cwts	Cwts.
United Kingdom . . .	588,164	653,725	478,981	674,765	699,943
Australian Commonwealth . . .	25,099	10,700	27,209	23,531	27,147
Ceylon . . .	192	2,679	1,923	2,165	1,260
Straits Settlements, including Labuan . . .	93	268	304	445	667
Hong Kong . . .	6,403	7,642	2,937	1,676	1,457
Cape of Good Hope . . .	3,100	2,200	1,998	3,797	2,326
Other British Possessions . . .	100	27	59	1,121	514
Total British Empire	623,151	677,283	513,739	707,500	733,314
Germany . . .	143,932	165,194	81,759	130,772	242,341
Netherlands . . .	14,359	34,308	22,052	55,656	65,542
Belgium . . .	62,690	71,413	44,427	66,902	71,762
France . . .	102,993	113,448	67,162	91,058	140,979
Italy . . .	16,969	10,033	200	1,800	2,300
Japan . . .	15,590	23,484	23,062	20,795	24,731
United States . . .	326,390	227,535	282,995	285,584	634,075
Other Foreign Countries . . .	18,677	16,661	7,161	17,566	12,443
Total Foreign Countries	701,600	662,076	528,818	670,133	1,194,173

United Kingdom Trade in Myrobalans

	1923	1924	1925	1926.	1927.
Total Imports quantity (cwt.)	492,007	757,151	539,309	625,689	677,978
Total Imports value (£)	188,158	319,582	315,022	311,540	344,002
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
British India . . .	489,672	752,768	533,958	625,479	675,857
Other British Countries . . .	—	1,470	2,972	—	200
Total British Countries . . .	489,672	754,238	536,930	625,479	676,037
Total Foreign Countries . . .	2,335	2,913	2,379	210	1,921

Re-exports

Total Re-exports quantity (cwt.)	5,456	13,091	23,430	22,914	38,276
Total Re-exports value (£)	1,953	5,797	13,621	11,326	15,673
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
Total British Empire . . .	128	330	290	67	525
Sweden . . .	—	—	504	(a)	(a)
Germany . . .	1,073	3,341	14,483	18,840	33,808
Belgium . . .	—	—	665	(a)	(a)
France . . .	1,176	4,945	1,743	3,240	567
United States . . .	1,867	4,370	4,645	207	311
Other Foreign Countries . . .	1,212	105	1,100	560	3,065
Total Foreign Countries . . .	5,328	12,761	23,140	22,847	37,751

(a) Not separately recorded.

a fluctuation varying from about one-sixth to one-third of the amounts exported to the United Kingdom.

In addition to whole and crushed myrobalans, the solid extract has for many years been a regular article of commerce, and considerable quantities are now exported, generally in solid blocks containing between 50 and 60 per cent. of tannin. Solid extract of myrobalans is prepared in the East Indian Tanning Extract Factory, Raniganj, Bengal, which Presidency, according to the official returns, is responsible for practically the whole of the extract exported from India. It is usually packed in bags, cases or kegs, of about one hundredweight each. There is a good demand for it in the United Kingdom, which country, as will be seen in the accompanying table, showing the exports during the five years ending 31st March, 1928, is by far the largest consumer. It is stated that this solid extract furnishes a far less satisfactory tanning material than the fruits themselves as regards the deposition of bloom, the formation of acid liquors, and the improvement in the colour of the leather. For this reason British tanners prefer as a rule to make for themselves a liquid extract containing from about 25 to 30 per cent. of tannin; considerable quantities of myrobalans are now utilised in this way.

Exports of Myrobalan Extract from India

—	1921-22.	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28.
Total Exports quantity (cwts.) .	39,944	60,888	62,344	42,619	30,567	38,156	59,594
" " value (rupees) .	488,914	834,069	840,781	536,454	389,422	483,347	823,567
<i>British Empire</i>							
United Kingdom	23,853	33,902	36,429	23,778	18,316	18,113	28,502
Cape of Good Hope	1,838	1,972	1,673	1,444	1,925	6,155	3,761
Natal	40	280	40	40	175	667	140
Canada	—	—	358	666	—	395	508
Australian Commonwealth	3,194	7,163	4,162	3,750	1,076	2,228	2,030
New Zealand (including Nauru and British Samoa)	202	212	20	224	—	222	315
Hong Kong	—	400	48	—	—	—	21
Total British Empire	29,127	43,929	42,730	29,932	21,492	27,780	35,277
<i>Foreign Countries</i>							
Germany	4,039	6,386	4,186	2,618	2,658	5,177	8,774
Belgium	2,324	2,060	3,097	1,191	375	506	1,944
France	1,545	2,110	3,809	3,082	3,552	2,597	3,323
Italy	821	642	2,524	2,101	930	—	469
Netherlands	—	—	—	300	381	100	2,073
United States	1,149	3,978	4,063	1,242	765	915	—
Other Foreign Countries	939	1,783	1,935	2,153	414	1,081	7,734
Total Foreign Countries	10,817	16,959	19,614	12,687	9,075	10,376	24,317

DIVI-DIVI

Divi-divi is the name applied to the pods of a tree, *Cæsalpinia coriaria* Willd. (N.O. *Leguminosæ*). The tree is indigenous to Mexico, West Indies, Venezuela, Colombia and North Brazil. It has been successfully cultivated in India (especially in the Madras Presidency), Australia, Java, Tanganyika, Gold Coast and Mauritius. Mature trees are stated to yield 300 lb. of pods per annum. The pods contain on an average from 40 to 45 per cent. of tannin, and also appreciable quantities of glucose. The tannin in the pods is located in the tissue lying just beneath the epidermis, the seeds being free from it.

When used alone in tannage, divi-divi pods yield a leather which is strongly affected by climatic conditions. In damp weather the leather is soft and spongy, while in drought it loses its pliability. The pods are, therefore, generally blended with other materials, and are used chiefly as a partial substitute for gambier in dressing leather. They may also be utilised in the rapid drum-tannage of light leather.

On account of the high percentage of glucose in the pods the liquors are very liable to ferment, while at times they suddenly develop a deep red colouring matter. The use of antiseptics has been found to prevent the latter change. The problem of the fermentation is being investigated in India, where the pods are used in the local tanneries.

The chief countries from which the world's supplies of divi-divi pods are derived are Venezuela, Colombia, Dominican Republic, the Dutch West Indies, India and Jamaica. In Venezuela two factories were established during the war and manufactured a solid extract containing 80 per cent. of tannin.

The exports of pods from various countries for the years 1921-27 (inclusive) are shown in the table on p. 75.

Prior to 1914 Germany was the best market for this material, but since then the United States of America have occupied the premier position.

From the table it is seen that India and Jamaica are the only parts of the British Empire that export divi-divi pods, and that the quantities from these sources are quite small in comparison with those from South America. In 1926-27, the total exports from India (Madras Presidency) amounted to 357,728 lb., which was shipped entirely to Germany, France and Belgium.

Trials have been carried out in several parts of the Empire to ascertain whether *C. coriaria* could be successfully grown there. In Tanganyika, cultural experiments carried out before the war proved satisfactory and showed that the conditions were suitable, pods containing as much as 42 per cent. of tannin being harvested. Divi-divi grown in the Gold Coast was found on examination at the Imperial Institute to be low in tannin (33 per cent.) when compared with pods from Central America (40-45 per cent.). Similar low results were obtained with divi-divi grown in Mauritius and in Queensland, as is shown in the following table of analyses carried out at the Imperial Institute with divi-divi from various parts of the British Empire.

Results of Examination of Divi-divi Pods at Imperial Institute

—	Madras.		Mauritius.			Gold Coast	Queensland ¹
Moisture . . . per cent.	9.3	9.6	11.3	12.2	8.8	14.4	15.9
Insoluble matter per cent.	23.9	27.1	42.9	39.4	38.1	37.9	26.6
Extractive matter (non-tannin) . . . per cent.	24.9	21.5	24.6	22.5	21.1	14.6	14.3
Tannin . . . per cent.	41.9	41.8	21.2	25.9	32.0	33.1	43.2
Ash . . . per cent.	2.3	2.3	2.4	2.2	2.5	1.3	2.2
<u>Tintometer Readings</u>							
Red	3.0	2.1	4.6	6.5	3.5	—	—
Yellow	10.5	5.3	26.2	33.2	10.8	—	—

¹ Pods free from seeds.

Tanners in the United Kingdom are prepared to use greater quantities of divi-divi pods and would welcome increased supplies. Extension of the cultivation can therefore be recommended as the product would find a ready market.

Exports of *Divi-divi* (lb.)

Whence exported	1921-22.	1922-23.	1923-24	1924-25	1925-26	1926-27.	1927-28
India Madras Presidency, to							
United Kingdom	124,208	292,656	216,272	89,600	242,816	-1	-1
Germany .	384,720	303,408	285,152	643,216	295,680	-1	-1
Belgium .	-	22,176	1,792	-	-	-1	-1
France .	-	-	-	12,096	89,600	-1	-1
Italy .	-	-	-	68,992	-	-1	-1
Japan .	109,312	-	-	-	-	-1	-1
Total for Madras Presidency .	618,240	618,240	503,216	813,904	628,096	357,728	-1
Jamaica to:	1921.	1922.	1923.	1924.	1925.	1926.	1927.
United Kingdom	-	137,857	141,194	210,040	-	14,464	150,561
Belgium .	-	-	-	-	40,437	-	-
Germany .	302,971	13,297	2,250	89,951	148,211	143,688	21,937
Netherlands .	-	28,355	58,284	27,332	56,226	-	-
Total for Jamaica.	302,971	179,509	201,628	327,323	244,874	253,503 ^a	172,498
Colombia .	-1	3,508,768	4,522,608	2,171,857	1,950,630	3,907,155	-1
Curaçao .	1,785,240	(£27,600)	(£1,200)	-1	-1	-1	-1
Venezuela .	-1	6,920,560 ^b	9,214,924	7,918,972	8,029,172	6,688,878	9,827,375

¹ Figures not available. ² Six months only, July-December. ³ 93,077 lb. to France in 1926.

ALGAROBILLA

The pods of the plant *Caesalpinia brevifolia* Baill., well known to the tanners of the United Kingdom and other countries as Algarobilla, contain about 45 per cent. of tannin, and are similar in character to divi-divi, but less prone to cause discoloration. The world is dependent on Chile for supplies, but the export from that country is very irregular. It amounts in some years to 2,000 tons, of which the United Kingdom and Germany are the principal consumers. The algarobilla bush is not known to occur in a wild state in any part of the British Empire, and attempts to cultivate it have hitherto been unsuccessful. The bush is a native of Chile, where it grows inland at heights from 1,000 to 4,000 feet above sea level. It is very hardy and drought-resistant. In its natural habitat the winters are cold with frosty nights and some snow. Four inches of rain or its equivalent in snow during the winter is enough to ensure a good crop of pods, and a dry summer is stated to be necessary. For many years a regular and larger supply of pods has been desired by English tanners, and in 1910 the Imperial Institute initiated cultivation trials in those countries of the Empire where

the climate appeared promising for the purpose. A supply of seed was obtained from Chile and distributed to Rhodesia, Cape Province, Uganda, Kenya, Cyprus and India, but the results were unsatisfactory. Prior to these experiments seed had been distributed from Kew as far back as 1875 to Australia, the Bahamas, Barbados, Bermuda, South Africa and India. The cultivation of the plant did not prove successful in any case. This was attributed to the peculiar requirements of the plant as regards climate, and it was considered doubtful whether there existed within the Empire an area which possessed a cool climate combined with so small a rainfall as that belonging to the natural habitat. As a result of representations made recently by the United Tanners' Federation to the Imperial Institute Advisory Committee on Tanning Materials on the desirability of algarobilla production within the Empire, the possibilities of Empire cultivation are being re-investigated, and for this purpose seed has been distributed from Kew to Australia, South Africa, Kenya, Tanganyika, Nigeria, Cyprus and Bermuda.

TERI PODS

The pods of *Cæsalpinia digyna* Rottl. provide a tanning material similar to divi-divi and algarobilla. The plant is a thorny, scandent shrub found plentifully in a wild state in many parts of Burma, and in Bengal and Assam. The pods have been examined at the Imperial Institute and found to contain from 22 to 27 per cent. of tannin, while the pod-cases, free from seeds, contained up to 52 per cent., these results being expressed on material containing about 13 per cent. of moisture. In tanning trials the pods compared very favourably with divi-divi, and were well spoken of by tanners as being suitable for both light and heavy leather tannages. Occasional small consignments have been disposed of in this country, but it was found that the wild pods could only be procured in small quantities and at an excessive cost on account of the difficulty of collection, consequent upon the thorny nature of the shrub. The plant is abundant, but the pods do not

appear to be used to any great extent in India as a tanning material.

Acacia arabica (SANT, BABUL or GAMBIA) PODS

The pods of *Acacia arabica* Willd. contain up to 32 per cent. of tannin, while, after the removal of the seeds, which are free from tannin, the remaining pod-cases may contain over 40 per cent. The pods form an important source of tannin for use in the countries of origin, but attempts to establish a market in Europe have so far not been successful.

Sudan.—In the Sudan the pods are known as sant, sunt or garad pods. The sant trees occur abundantly in the forests of the Blue Nile and the White Nile as far south as parallel 12° N. Sant pods from the Sudan have been examined at the Imperial Institute (see BULLETIN OF THE IMPERIAL INSTITUTE, 1906, 4, 95 ; 1913, 11, 408), and found to contain about 30 per cent. of tannin. The seeds, which are very hard, amount to about 30 per cent. of the pods, and contain no tannin ; they are troublesome to the tanner, owing to the ease with which they ferment and the consequent rapid deterioration of the tan liquor. The tannin is located chiefly in a hard resinous-like deposit on the inner surface of the pods. A product known as "Sant Grains" has been prepared in the Sudan by crushing the pods and removing the seeds and most of the shell or pod-case by sifting. The "sant grains" so produced, amounting to about one-third of the entire pod, contain from 50 to 60 per cent. of tannin, depending largely on the extent to which the fibrous matter has been removed. Several trial consignments of the grains, produced by hand labour, have been forwarded to this country and favourably received, but the price obtained for the later shipments (1921) was not remunerative. Both the pods and the grains yield a pinkish-white leather which is fairly soft and of firm texture. Tanners who conducted technical trials with the material employed it in place of sumach for finishing skins tanned with bark, and reported that the results appeared to be quite satisfactory.

The tree is abundant in the Sudan and large supplies of the pods are available. They are used locally for tanning, and small quantities are regularly exported to Egypt, and occasionally to Italy. The quantity sent annually to Egypt varies from about 500 to 1,400 tons. It is stated that 2,000 tons of sant grains could be produced annually in the Sudan, but the development of a trade in the grains would be dependent on the introduction of suitable machinery in order to market the product at a remunerative price. The Sudan pods are a valuable and important Empire source of tannin and further efforts are now being made to place the material in a suitable form on the United Kingdom market. Efforts in this direction are being made under the auspices of the Imperial Institute Advisory Committee on Tanning Materials.

	Analyses made at the Imperial Institute.			
	Sant Pods freed from seeds		Sant Grains	
	I. Per cent.	II. Per cent.	I. Per cent.	II. Per cent.
Moisture	7·8	8·4	5·9	8·3
Ash	4·5	3·7	3·7	3·7
Tannin	38·9	41·0	60·9	52·5
Extractive matter (non-tannin).	15·7	19·3	21·7	22·7
Tintometer readings:				
Red	1·3	—	—	—
Yellow	2·6	—	—	—

India.—As already stated (p. 40) the *Acacia arabica* tree is common in Upper India, where it is known as Babul, and is greatly valued in that country on account of its bark. The bark forms the most important tanning material of the Cawnpore leather industry, but the pods, owing to their fermentative properties, have been utilised to only a small extent. These pods compare unfavourably in tannin content with the sant pods from the Sudan, containing only from 12 to 19 per cent. of tannin in the entire pods, and about 18 to 27 per cent. after the removal of the seeds ; they are, however, richer in tannin than the bark, and form an abundant source of tannin which should be of great importance when a successful method of application has been devised. At

present the pods are used as a cattle food in certain areas, but much of the material is entirely wasted. They are used to some extent by local dyers as a mordant for dyeing basic colours on cotton, and by tanners for drenching or bating, as after the liquor has fermented it is well adapted for the latter purposes. In 1915 investigations were commenced at the Technical Laboratory, Department of Industries, Cawnpore, for the purpose of determining the best means of overcoming the fermentation of the seeds in tanning operations. It was found that the fermentation could be sufficiently retarded by the use of an antiseptic so as to permit of the use of the pods in the same way as myrobalans. The antiseptic recommended was crude carbolic acid in the proportion of 0·3 to 0·5 per cent. of the weight of the pods used. It was intended to carry out trials on a commercial scale, but no further information has been published in this connection.

West Africa.—*Acacia arabica* is common in the dry zone throughout West Africa, and the pods are employed locally as a tanning material. In Nigeria they are known as Gabarru, and are largely used in the production of Kano leather. From time to time small quantities have been imported into the United Kingdom under the name "Gambia" pods, while the pods from the French possession of Senegal have recently attracted notice under the name "Gonakie" pods. Pods (including the seeds) from Northern Nigeria examined at the Imperial Institute were found to contain from 13 to 27 per cent. of tannin, while de-seeded pods contained from 19 to 38 per cent. They yielded a pale fawn-coloured, rather soft leather (see BULLETIN OF THE IMPERIAL INSTITUTE, 1913, 11, 411). Gonakie pods contain from 18 to 32 per cent. of tannin when ripe, while the half-ripe pods are stated to contain as much as 49 per cent. No regular export of these pods from West Africa has been established, though Senegal in 1922 exported over 500 tons. The pods are comparable as a tanning material with the sant pods of the Sudan, and would be of importance to European tanners when once the difficulty of application already referred to had been overcome.

TUBERS

CANAIGRE

The tubers of *Rumex hymenosepalus* Torr. contain in the fresh state about 9 per cent. of tannin and 68 per cent. of water, but when dried they contain on an average 30 per cent. of tannin, the amount ranging from about 18 to as much as 48 per cent. This plant, which is sometimes known as "red dock," "wild rhubarb" and "tanners' dock," occurs in the sandy plains of Mexico and Texas, and attracted attention many years ago as a source of tannin. It has, however, never fulfilled expectations, the chief difficulty in the way of the establishment of a canaigre industry being the fact that the supplies of the wild plant are not sufficient to furnish a steady production in such quantities as would be required by the trade, and farmers have not found it sufficiently profitable to cultivate. The plant is an annual, and is easily reproduced from tubers. The tubers, for tanning purposes, are left in the ground for two years before lifting as the tannin content increases up to the second year. After this stage the colour darkens and the quality of the material deteriorates. Poor soil conditions favour a high percentage of tannin, while on rich, well-irrigated soil the content is low. Trials have been made with the cultivation of this plant in Queensland and in the United Provinces, India. In the former country it is reported to have been successful, but in India the acclimatised tubers were found to contain only about one-half the amount of tannin usually found in the American-grown product. As a tanning material the tubers have been found very satisfactory, producing a soft, bright yellow leather of considerable weight and firmness. It is specially suitable for use in re-tanning and finishing light goods and harness. The softening effect in the tannage is very similar to that of gambier or sumach. There is no doubt that if regular consignments of the tubers were available, the material would be readily adopted by tanners, who have spoken very favourably of its properties. In countries where hand labour is cheap, cultivation might prove profitable, and the fact that the crop can be produced

within two years of planting is a feature that makes canaigre worthy of consideration for further trials.

MISCELLANEOUS TANNING MATERIALS

In the following section a number of lesser-known tanning materials are dealt with, which are not at present in commerce but which appear to be worthy of consideration either from the point of view of export or of local utilisation. It has not been possible, owing to limitations of space, to deal with many comparatively unimportant materials which have been investigated in various parts of the Empire, but the reader will find particulars of a number of such materials in the publications mentioned on p. 90.

A number of reports on miscellaneous materials from various countries have also been published in the *BULLETIN OF THE IMPERIAL INSTITUTE*, among which may be mentioned the following : Vol. IV (1906), No. 2, pp. 95-97 (Sudan) ; Vol. V (1907), No. 4, pp. 354-360 (Uganda, Somaliland and Sudan) ; Vol. IX (1913), No. 3, pp. 412-426 (Sudan, Cyprus, Nigeria, Hong Kong, Tasmania, Ceylon) ; and Vol. XXIII (1925), No. 2, pp. 158-168 (Travancore, India).

Anaphrenium argenteum E. Mey. (= *Rhus Thunbergii* Hook.). Kliphout. Anacardiaceæ.

This tree occurs in certain parts of the Cape Province, South Africa, principally in the Cedarberg Mountains. The bark contains a high percentage of tannin, and has been employed to some extent by local tanners for use in conjunction with wattle bark, which counteracts the tendency of Kliphout to produce a slight brittleness in the leather. An analysis of the bark at the Imperial Institute showed it to contain 33 per cent. of tannin, and analysis carried out at the Cedara laboratory indicated the presence of 34.2 per cent. of tannin in the bark, and 4.8 per cent. in the leaves and twigs.

Anogeissus latifolia Wall. Dhawa. Combretaceæ.

This is a large deciduous Indian tree met with in the Sub-Himalayan tract from the Ravi eastward to Central

and Southern India. The leaves and twigs of this tree, which is the principal source of commercial "Ghatti" gum, have been employed for many years in Indian tanneries under the name of "Country Sumach." The dry mature leaves of the tree contain about 16 per cent. of tannin, whereas the dry, reddish tips of young leaves have been shown to contain up to 55 per cent. of tannin. Experiments in India have demonstrated that pollarded trees will furnish yearly three crops, consisting of a mixture of green leaves, red leaves and petioles, which, when dried and coarsely ground to pass a ten-mesh sieve, yield a product containing 30 per cent. of tannin and 16 per cent. of soluble non-tannins. The tannin penetrates rapidly and produces a satisfactory pale-coloured leather having a greenish tinge. The dry bark of *A. latifolia* contains from about 10 to 15 per cent. of tannin, and gives excellent results in combination with avaram (*Cassia auriculata* bark).

Callitris spp. Australian pine barks, Cypress pines.
Coniferæ.

The barks of several species of *Callitris* have been shown to contain appreciable amounts of tannin; the most important is that of *C. calcarata* R. Br., Black Pine, which contains from about 10 to 36 per cent. of tannin, and on an average from 20 to 25 per cent., with a low percentage of soluble non-tannins (BULLETIN OF THE IMPERIAL INSTITUTE, 1926, 24, 702). This species is an evergreen tree reaching a height of almost 100 ft. It is very widely distributed throughout Queensland, New South Wales, and Victoria. Used alone the bark furnishes a red leather, having properties somewhat similar to those produced by hemlock bark, and inclined to be harsh but more water-resisting than wattle-tanned leather. *C. calcarata* bark gives good weight, and forms a most satisfactory sole-leather tannage when used in admixture with wattle. This bark has not been used to any great extent in Australian tanneries owing largely to supplies of the more valuable wattle bark being available. Experiments have indicated that the bark would be especially suitable for the manufacture of extract, but it seems doubtful whether it could be obtained

in sufficient quantity in any one place to permit of an extract plant being profitably operated; success would therefore depend on the provision of ample transport facilities.

C. glauca R. Br., White Pine, next in importance to *C. calcarata*, is even more widely distributed throughout Australia, occurring in all the States with the exception of Tasmania. Published analyses of the air-dried bark show the tannin content to be from about 9 to 23 per cent. with a low percentage of soluble non-tannins. As this bark contains a comparatively small amount of tannin, its value would depend on its utilisation for the manufacture of extract. The tannage is similar to that of *C. calcarata*.

Carissa spinarum A. DC. Karunda. Apocynaceæ.

A wild, thorny, evergreen shrub, which occurs in most parts of India and in large areas throughout the Central and Northern parts of that country. Leaves examined at the Imperial Institute contained 11 per cent. of tannin and 24 per cent. of soluble non-tannins. The bush coppices well, and it is possible to collect the leaves all the year round. The tannage is slow, causing extreme swelling of the hide, and if care is not taken "drawing" of the grain takes place. With admixture of other Indian tanstuffs very satisfactory results are obtained. The twig bark of *Phyllanthus Emblica* (q.v.), for instance, has been found to be an ideal ingredient, as its red effect neutralises the greenish coloration produced by *C. spinarum* leaves.

Cassia fistula Linn. Konna, Amaltas. Leguminosæ.

A moderate-sized tree known as the Indian laburnum. It is common throughout the plains of India and Burma. The bark contains up to 15 per cent. of tannin, and furnishes a smooth-grained, almost white leather. It is largely employed in India in admixture with avaram (*Cassia auriculata*) bark, and also mixes well with babul (*Acacia arabica*) bark.

Colpoon compressum Berg. (= *Osyris compressa* A. DC.) Cape Sumach. Santalaceæ.

The leaves and stems of this South African plant, although known as Cape Sumach, possess quite different

tanning properties from those of true sumach (*Rhus coriaria*). The tannin is of the catechol class, and the leather produced is stated to be spongy and porous. Cape Sumach may contain as much as 26 per cent. of tannin, though a sample examined at the Imperial Institute contained only 11 per cent.; the average is probably about 17 per cent. This material is hardly likely to be of importance for other than local use.

Elephantorrhiza Burchellii Benth. Elands Boontjes.
Leguminosæ.

The roots of this shrub, which occurs in most parts of South Africa, are several feet long, about 2 in. in diameter and contain a fair amount of tannin. The air-dried roots, with a moisture content of 10 per cent., contain about 17 per cent. of tannin, but the soluble non-tannin matter is undesirably high, viz. about 23 per cent. The roots produce a soft but fairly tough leather, but owing to the objectionable deep red colour of the infusion the material cannot be used in the production of a leather of good quality. At one time it was largely used in local tanning, and is still preferred for certain uses. The material is not sufficiently rich in tannin for export purposes, and in view of the excessive amount of soluble non-tannins present it would not be suitable for the production of extract. The available supplies moreover are not sufficient for the establishment of an overseas trade, and the material is not of such value as to warrant the cultivation of the plant.

Eucalyptus alba Reinw. Ridge gum of the Kimberleys, North-West Australia; Poplar gum of tropical Queensland. Myrtaceæ.

This species is widely distributed, not only in tropical Australia, but also in the Eastern Archipelago. In Australia it is confined mostly to tropical regions, extending over the north from Queensland to the Kimberleys and North-West Australia generally.

There is a great difference between the amount of tannin in the bark of trees grown in the Kimberleys and that in the bark from Queensland, the average content of the

former being 30 per cent., and of the latter only 7 per cent. The ratio of tannin to non-tannins in the Kimberleys bark varies from 2 : 1 to 3 : 1. The bark contains kino, which probably constitutes the main part, if not all, of the tannins. Small-scale tanning trials with the bark from the Kimberleys have indicated that it is likely to prove a valuable tanning material. Adequate supplies are believed to exist. Leather prepared from ridge gum tannins is light-coloured and in the crust state is comparable in colour with such tannages as sumach and is superior to wattle. It is suggested that this material might advantageously be employed blended with wattle or mangrove bark.

The wood, leaves and twigs of this tree grown in both Western Australia and Queensland contain fair quantities of tannin, but the percentage of non-tannins, being in many cases, nearly, if not quite, as high as that of the tannins, would render these parts of the tree unsuitable for extract manufacture.

Ridge gum bark is a promising tanning material and, if ample supplies are available, it could be utilised for the preparation of a tannin extract. It is understood that the Western Australian Government may take steps to have the area examined and the available supplies ascertained.

***Eucalyptus calophylla* R. Br. Red-gum or Marri.**

This tree occurs with jarrah (*E. marginata* Sm.) and karri (*E. diversicolor* F. Muell.) in the extreme south-west of Western Australia. The principal form of the raw material to be used for tanning purposes would be the kino-impregnated bark. This material could be collected in large quantities, the supplies being almost unlimited. The tannin content of the kino is high, whereas the bark and wood when free from visible kino contain only a small amount of tannin. The kino exhibits two features undesirable in tanning materials, viz. its insolubility in water and its deep red colour. The former has been overcome by treatment with alkaline sulphites under pressure in an autoclave, when a small loss in tannin and a slight increase in non-tannins and insolubles result. It is stated that

sulphited or soluble marri kino might replace the quebracho extract in use in Australian tanneries. The use of precipitants, such as aluminium sulphate, for the reduction of the high colour is not recommended. It is preferable to overcome this disadvantage by blending the soluble marri kino with lighter-coloured materials, e.g. extracts prepared from karri (*E. diversicolor*) and tuart wood (*E. gomphocephala* DC.). Wattle bark might also be used for this purpose. Marri kino contains from 57 to 69 per cent. of tannin and 9 to 11 per cent. of non-tannins. Laboratory tanning trials with sulphited marri kino have given promising results.

***Eucalyptus diversicolor* F. Muell. Karri.**

This species is confined to Western Australia and occurs in dense forest in the extreme south-west corner of the State. The wood is low in tannin. The bark is regularly available in large quantities from logging and milling operations and could be collected cheaply. The tannin content of the bark varies from 11 to 22 per cent. and the non-tannins from 5 to 11 per cent. Karri bark extracts are light-coloured, and in laboratory-scale tanning tests have produced leather of favourable colour. The bark can be considered a suitable raw material for the manufacture of a good tannin extract. A cheap and useful tanning material can also be produced from this bark by blending it with sulphited marri kino (*E. calophylla*).

***Eucalyptus gomphocephala* DC. Tuart.**

This species is confined to Western Australia, where it forms a fairly dense forest along the coast line south of Perth. The timber is commercially exploited. The bark is relatively poor in tannin, containing up to about 6 per cent. The wood is considerably richer in tannin, and it is suggested that the waste material from the saw-mills could be successfully utilised for the manufacture of extract. These waste products contain up to 10 per cent. of tannin, while the ratio of tannins to non-tannins is about 3 to 1. It is suggested that tuart wood extract might also be blended with sulphited marri kino (*E. calophylla*) to produce a useful product.

Hopea parviflora. Beddome. Thumpagam bark, Iron wood.

A large handsome evergreen tree found in the forests of Malabar and South Kanara. The tree is much valued locally for its timber, the wood being very hard and durable. Samples of *H. parviflora* bark examined at the Imperial Institute and in India have been found to contain from about 12 to 26 per cent. of tannin, and from about 5 to 10 per cent. of soluble non-tannins. The leather produced is of good quality and fairly pale in colour, though slightly darker than is required for the South Indian export trade.

Phyllanthus Emblica. Linn. Aoula. Euphorbiaceæ.

A moderate-sized deciduous tree, found almost throughout India and Burma. The bark, leaves and fruit of this tree have long been employed by natives in India for tanning. Pilgrim has shown that whereas the dry bole bark contains on the average only about 8 to 9 per cent. of tannin, the dry twig bark contains as much as 24 per cent., together with about 17 per cent. of soluble non-tannins. The dry leaves contain from 23 to 28 per cent. of tannin, and the dried full-grown unripe fruits may contain 35 per cent. of tannin. *P. Emblica* bark produces a very smooth-grained, reddish leather, with a steady swelling of the hide during tanning. A sample of *P. Emblica* leaves (air-dried) from Hong Kong, examined at the Imperial Institute, contained 16.8 per cent. of tannin and 11.9 per cent. of soluble non-tannins. It furnished a soft leather of firm texture, pale cream in colour, with a faint greenish-yellow tinge (BULLETIN OF THE IMPERIAL INSTITUTE, 1913, 11, 426).

Pinus halepensis Mill. Aleppo pine.

The bark of this species is an important tanning material on the Mediterranean coasts. The outer bark contains about 15 per cent. of tannin, whereas the inner bark, which yields a paler-coloured tannin, contains up to about 25 per cent. A sample of air-dried bark from this species grown in South Australia, where it is stated to cover a small area, was found to contain 20.5 per cent. of tannin and 8.4 per cent. of soluble non-tannins.

Pinus longifolia Roxb. Chir pine.

This species, which is the main source of Indian turpentine, furnishes bark containing from about 11 to 14 per cent. of tannin, and is used to some extent in native tanning.

Pinus Khasya Royle. Burma Hill pine.

This pine, as the common name indicates, is found in the hills of Burma ; it occurs also in the Shan States. Pilgrim, who has examined the tanning value of the bark of this tree, commends it as a valuable potential tanning material for medium and heavy leathers. Two samples of the bark examined by him contained about 7 and 10 per cent. of tannin (expressed on the dry material), with about half as much soluble non-tannins (*Indian Forest Bull.*, No. 57, 1923).

Shorea robusta Gaertn. Sal. Dipterocarpaceæ.

A large gregarious tree best known for its timber. It occurs in India from the provinces of Bengal and Bihar to the foot of the Himalayas. In the production of timber large quantities of this bark become available, and it has long been used successfully as a local tanning material. The bark contains from 3 to 9 per cent. of tannin, and furnishes a very tough, reddish-coloured leather. Experiments were carried out at the Imperial Institute some years ago in the preparation of a tannin extract from this bark, and a suitable process was devised for decolourising the extract. It was considered in India, however, that it would be more profitable to manufacture mangrove extract. The fully-grown dry leaves of the tree contain from 8 to 10 per cent. of tannin, and the dry young leaves with their twigs 23 per cent. A mixture composed of two parts of bark and one part of young leaves has been found to produce an excellent leather of pale colour, though the penetration is very slow.

Terminalia Arjuna Bedd. Kahua. Combretaceæ.

A large deciduous tree occurring on banks of rivers and streams throughout Central and Southern India,

extending as far north as Oudh. The bark of this tree, which for many years has been employed to some extent by natives for dyeing and tanning, was first introduced to the tanneries of Cawnpore in 1915, and has since become a well-established and important Indian tanstuff. The dry bole bark contains from 20 to 24 per cent. of tannin, and the dry bark from the lower branches about 18 per cent. *T. Arjuna* bark tannage is capable of wide application, and can be used for the production of fine upper leather and excellent sole leather. The tannin, like that of oak bark, belongs to the pyrogallol and catechol class. The colour of the leather is a light brown, with no excessive red tint. The dry fruits of the tree, when green and nearly fully-grown, contain about 20 per cent. of tannin ; it is said, however, that they do not produce good leather. -

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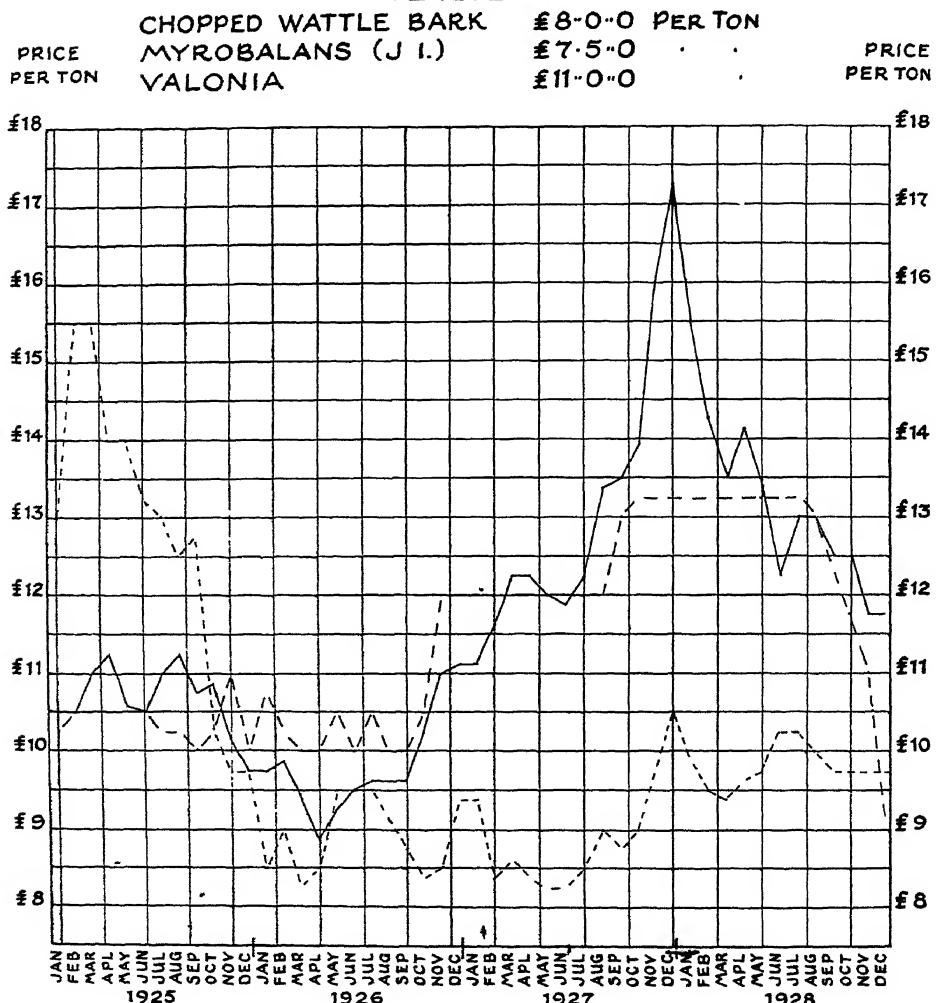
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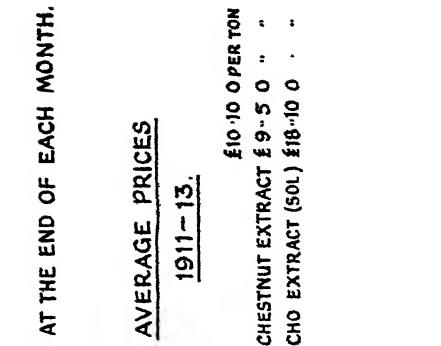
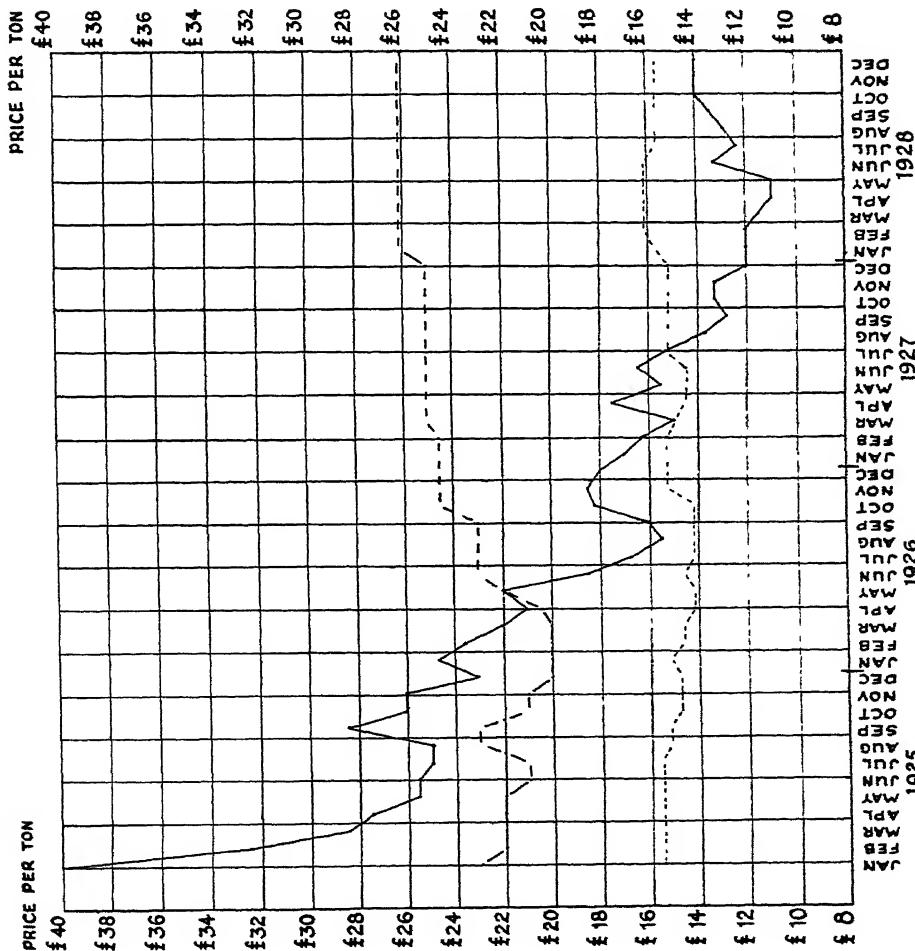
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